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CHARGING CURRENTS OF THREE-PHASE TRANSMISSION LINES WITH ONE CONDUCTOR GROUNDED.

In the case of alternating-current lines operated at a pressure of two or three kilovolts, as in primary systems of distributing mains, the charging current of the lines is ordinarily unimportant. Only in cases where extensive primary distributing systems are operated, especially in underground conduits, does the charging current of the system, at, say, 2 kilovolts pressure, come into prominence. When, however, high-pressure transmission systems are employed the charging currents of the systems under no load may be nearly as great as the working components of current under maximum load. Any dissymmetry of charging current on the lines of such a high-pressure system may give rise to unbalancing of voltages, either in the generator or in the lines themselves. The charging currents of such systems, in their regular operation, thus assume considerable importance. Any symmetrical three-phase system, if not connected directly to ground at its generating neutral point, may be regarded as having zero potential at that point and as being virtually grounded there so long as the system remains insulated and balanced. Consequently, each wire is virtually operated at star voltage against ground and the other two wires jointly. That is, the presence of the ground, as a conducting sheet, somewhat disturbs the charging potentials and currents of the three lines. If the towers carrying the wires were indefinitely high, so as to keep the ground surface at an indefinitely great distance away from the line, the three line wires remaining spaced equidistantly on the vertices of an equilateral triangle, the three charging currents should have exactly equal strength. In any actual case the vicinity of the ground causes the charging currents of the lower wires to exceed that of the higher wire or wires. It is interesting to note that Clerk Maxwell, long before the day of electric energy transmission, and even of alternating-current development in any of its phases, disclosed the general formula by which the charging current might be computed in any given case.

In an article we publish this week Mr. George S. Humphrey computes the potentials and currents of a set of three aerial three-phase lines under various conditions of grounds and grounding. He shows that when the three wires are each of No. 0 gage, on 6-ft. upright equilateral-triangle vertices, the base being 25 ft. from the perfectly conducting ground, the charging currents in the lower wires are greater than that in the top wire, owing to the presence of the ground, to the extent of 0.1 per cent. The addition of a grounded wire of 0.25 in. diameter, 3 ft. vertically above the top line wire, as is sometimes adopted for lightning protection, adds 1 per cent to the charging current of the bottom wires and 2 per cent to that of the top wire.

If, however, one of the bottom wires is grounded, the charging current of that wire is reduced, being diverted in considerable measure to the ground; but, on the other hand, the charging current of the two other wires is increased about one-third and the charging current system becomes distinctly unbalanced. The case is also considered of the three wires placed on the same level cross-arm of a pole, at a spacing of 1 ft., and all at a level 40 ft. above the ground. Such a charging system is essentially unbalanced for geometrical reasons, the middle wire receiving the greatest charging current. The grounding of one of the side wires is then shown to reduce the charging current of the grounded wire, but to increase that of the two other wires by about a third, a charging current being also communicated to the ground; so that the total charging current on the grounded line terminal is about double the normal. Outside of the arithmetical details of each case considered, the article shows that when a three-phase aerial line system is insulated the effect of the ground's vicinity on the charging currents of the lines is negligible at ordinary line elevations. When, however, one line of the system is grounded, either at generator terminals or at some point along the system, the charging current doubles up on the generator terminal that takes the ground, while those of the other two lines increase each about one-third.

THE MAGNETIC PROPERTIES OF STALLOY.

As noted in this week's *Digest*, our British contemporary *The Electrician* has recently printed, in abstract, a paper by Messrs. H. R. Hamley and A. L. Rossiter, read before the Royal Society of Victoria (Australia), on the magnetic properties of stalloy, a special brand of iron alloy prepared for the purpose of maintaining good magnetic permeability, with as low electric conductivity as possible. It appears from the tests reported that stalloy behaves differently in the annealed and unannealed conditions, the behavior when annealed being much the better for practical purposes. Annealed stalloy is stated to compare very favorably with the best soft iron in regard to permeability and hysteretic coefficient, while its electric resistivity is some four times as large as that of soft iron. The result claimed for stalloy is, therefore, a reduction in total iron losses of about one-third by comparison with ordinary transformer-core iron. Several different brands of iron have recently been produced looking toward the same purpose as stalloy. Eventually we may hope to be able to dispense with laminations in armature and transformer cores, casting them solidly in the form of cylindrical rings, with ventilating ducts permeating the mass. It must be confessed, however, that we are still a long distance away from this much to be desired goal.

MAGNETIC PROPERTIES OF IRON AT ABNORMAL FREQUENCIES.

It is only a little while since a frequency of 10,000 cycles per second was looked upon as enormously high in an alternating-current generator, and, of course, it must be so by comparison with the industrial frequency of 60 cycles per second. But within the last two or three years alternators have been built and put into operation at a frequency of 100,000 cycles per second. At the last meeting of the American Institute of Electrical Engineers, however, this record was raised, and the paper of the evening, by Mr. E. F. Alexanderson, dealt with the magnetic properties of iron at frequencies up to 200,000 cycles per second. That is, alternators of 5 kva are now built for this highest machine frequency. The most important application of these highest frequency machines is to wireless communication. The speed of the wave propagation, over land and sea, being generally admitted to be 300,000 km per second, a frequency of 100,000 cycles per second produces a wave-length of 3 km. If the sending antenna were vertical and unloaded, it would have to be approximately one-quarter of a wave-length in height, or 750 meters high, in order to be tuned to this frequency. Loading the antenna with reactance, however, enables a much shorter antenna to resonate to this frequency. With the mechanical generation of 200,000 cycles per second, the wave-length becomes reduced to 1500 meters and the free height of an unloaded resonating air-wire to about 375 meters. It becomes, of course, still easier to load an air wire of, say, 90 meters in height to resonance with this frequency, so as to keep it in full oscillation and radiation.

It has always been a matter of debate whether at frequencies such as these iron behaves in essentially the same manner as at ordinary electric-lighting frequencies. Of course, the skin effect, or imperfect magnetic penetration, becomes greatly exaggerated at these frequencies, even with the thinnest sheets or wires of soft steel that can be worked. In other words, it is impracticable to obtain or handle sheets or wires of steel so thin that the alternating magnetism can permeate them, even to 50 per cent of the full steady value, so that the thinnest iron that can be used is mainly non-magnetic material under such conditions, with a thin layer of magnetic material on each surface. However, allowing for the proper depth of available magnetic layer, the results which Mr. Alexanderson has obtained go to show that the working layer of iron acts magnetically substantially in the same manner and to the same extent as at customary low frequencies. In fact, the results show that an alternating-current transformer, if properly designed, has a higher efficiency and a higher specific output at 200,000 than at 60 cycles per second, though the increase in output is far below that corresponding to the frequency ratio. Of course, the regulation behavior of the high-frequency transformer would be very poor by comparison with that of the low-frequency transformer.

A NEW SOUND-RECORDING AND SOUND-REPRODUCING APPARATUS.

We are so accustomed to the already existing types of sound-reproducing apparatus that a new type comes to us as a surprise. We refer in our *Digest* to a new sound-recording and reproducing apparatus recently exhibited at the French Académie des Sciences and invented by M. S.

Lifschitz. In the recorder an arc-light beam is reflected onto a rapidly moving sensitized cinematograph strip from a mirror supported before the transmitter diaphragm. Speaking to the transmitter, its diaphragm vibrates, and this in turn vibrates the little mirror, which in turn vibrates the reflected light beam. A tremulous wavy line is thus photographed on the strip. A final record strip is then produced, with holes or serrations etched out photographically, in conformity with the original photographic record. The final strip with the holes is now run over the surface of a block provided with a slit aperture from a compressed-air chamber. As the holes in the strip pass over the slit the air escapes in a rapid succession of puffs or impulses, as in the siren disk, except that, whereas in the ordinary disk siren the holes come at regular intervals and produce a more or less musical steady note, in the phonographic band siren they come at less regular intervals and reproduce vocal sound. Listening to the apparatus is thus listening to the voice of the siren, in a manner not contemplated or claimed by the original poet. One advantage of the apparatus, in spite of the relative intricacy of the recording process, is the visibility of the sound record.

NULL METHODS IN ALTERNATING-CURRENT MEASUREMENTS.

One of the papers on electrical measurement read at the International Electrotechnical Congress of Turin was by Messrs. Barbagelata and Emanueli, on null methods in alternating-current measurements. In all electrical testing laboratories direct-current measurements are made, as far as possible, by null methods. For instance, the measurement of resistance by Wheatstone's bridge owes its precision and convenience to the fact that it is a null method, the adjustment of resistance being made in the test until the galvanometer shows no current. Similarly, the potentiometer of Poggendorf and Latimer Clark, as ordinarily used for the direct-current measurement of voltages or current strengths, owes its popularity likewise to being a null method. In alternating-current measurements there have been two difficulties to contend with in the past when seeking to apply null methods. The first difficulty has been to find a sensitive and yet convenient form of alternating-current galvanometer to reveal the presence of very feeble currents, or alternating currents when nearly reduced to zero. The second difficulty has been with phase differences in potential.

As regards the first difficulty, the ordinary D'Arsonval type of galvanometer was manifestly useless for alternating-current purposes. Moreover, instruments of the electrodynamometer type were not available as ordinarily used, because, their deflections being proportional to current squares and not to currents in simple proportion, their sensibility to very feeble currents was necessarily very low. The telephone was available, of course, as a substitute for a galvanometer; but for frequencies below 100 cycles per second the telephone is practically useless for accurate work, owing to insensitiveness, notwithstanding its extraordinary sensitiveness to alternating currents of frequencies from 500 cycles to 2500 cycles per second. It was not until the vibration galvanometer was developed that a satisfactory degree of sensitiveness to low-frequency alternating currents could be obtained. There are a number of types of vibration galvanometer, but all employ the principle of mechanical resonance, whereby a suspended system is tuned into synchronism with the alternating current, and is then acted upon electromagnetically by the current. A very small alternating deflection produced by the current on the suspended system thus soon builds up a powerful resonant vibration. As regards the second difficulty of phase differences, it is evident that we might make up a Wheatstone bridge with two non-inductive ratio-coils, a third arm containing a condenser, and the fourth containing an inductance. We might then supply alternating currents to the bridge and use a vibration galvanometer; but the current through the galvanometer could never be brought to zero, owing to the difference in phase of the potentials on the two sides of the bridge.

Any general null method of the potentiometer type applicable to alternating currents must, therefore, be capable of reducing to zero the phase of potential applied to the galvanometer before attempting to reduce the current strength to zero. The paper above referred to discusses the general plan of making such alternating-current null methods, and describes the particular apparatus already in use. One general method is to use a rotating-field transformer, so that, by changing the position of the secondary coil in the rotating field, the secondary emf can have its phase varied at will. The phase of the potential difference to be measured is thus adjusted into coincidence with that produced in the secondary coil of the transformer, after which the magnitudes of potential difference can be adjusted into equality, by opposition, through a vibration-galvanometer. The second method produces the required coincidence of phase by the addition of a perpendicular component instead of by the rotation of the plane of a secondary coil. The paper describes several types of vibration galvanometer, some of which are especially sensitive to low-frequency alternating currents, while others are particularly sensitive to alternating currents of telephonic frequencies. It also discusses the separate excitation of the electrodynamometer, so as to secure a relatively high sensibility with that instrument. The sensibility to feeble low-frequency alternating currents which can be obtained without difficulty in vibration galvanometers is wonderful. In fact, they are often so sensitive that the alternating stray fields from wires in their neighborhood may affect them seriously. In such cases it may become necessary to employ compensating alternating-current electromagnets, supported at an adjustable distance away from the galvanometer. Since the phase of the alternating magnetism thrown out by such compensating magnets may not be sufficiently near to that of the disturbance to be eliminated, it is shown in the paper that a rotating-field compensating electromagnet can be used, in which case not only the distance but also the azimuth of the device must be adjusted with reference to the vibration galvanometer in order to obtain complete compensation.

Seattle N. E. L. A. Convention.

A meeting of the transportation committee of the National Electric Light Asociation was held in New York City Nov. 22. Mr. C. H. Hodskinson, chairman, announced that the Transcontinental Passenger Association had authorized reduced round-trip fares on account of the Seattle meeting as follows : From Chicago, $65; from St. Louis, $62.50; from Missouri Gateways (Omaha to Kansas City inclusive), $55; from St. Paul, $55. Dates of sale for tickets under reduced fares were authorized as follows: May 27 and 28 and June 3 to 6 inclusive, the final return limit being July 27, 1912. Application has been made to the Eastern passenger associations for a fare and a half to the gateways of the Transcontinental Passenger Association, and as soon as an official tender is received from these associations complete details regarding the cost of transportation to the convention will be announced.

Details regarding special tours to Seattle were discussed and plans were formulated for several different tours, one of which is a *tour de luxe* embracing all the scenic wonders of the West. Another is a direct tour to Seattle with choice of returning routes. A third tour calls for a fast schedule from the Atlantic seaboard to Seattle and return for the benefit of members of the association whose time is limited. Detailed itineraries are in the course of preparation and will be distributed to the membership at an early date. The committee is making a special effort this year to make the trip to the convention the most elaborate, comfortable and interesting that has ever been afforded to the members.

The committee was most fortunate in having in attendance Mr. W. J. Grambs, of Seattle, who came all the way to participate in the conference. Mr. Grambs has accepted the responsibility of making all the arrangements on the Pacific Coast for the comfortable return after the convention to their respective destinations of members who have not made arrangements for the special trains. Members will be enabled to transact all their business with regard to transportation in a suite of offices engaged at Seattle by the transportation committee in the convention building, where representatives of the railroads will be present.

Provisions for exhibits at the Seattle meeting are now being made by a committee of Class D members. Plans are being drawn and spaces platted, and detailed information will be available for manufacturers by Jan. 1. It is believed that the manufacturers of apparatus and material used by lighting companies will take advantage of the opportunity that will be offered to show their apparatus in the western part of the country, and it is the desire to make the exhibit not only very interesting but typical of Western conditions.

Manufacture of Electrical Machinery, Apparatus and Supplies.

A preliminary statement of the general results of the thirteenth census of establishments engaged in the manufacture of electrical machinery, apparatus and supplies has been issued by the Bureau of the Census. The manufacture includes dynamos and dynamotors, transformers, motors, storage and primary batteries, arc and incandescent lamps, searchlights, transmitters and receivers, rheostats and resistances, electric welding and therapeutic apparatus, electric switches, signals and attachments, and similar machinery, apparatus and supplies.

The general summary shows increases in all the items at the census of 1909 as compared with that for 1904.

The number of establishments increased 29 per cent; capital invested, 54 per cent; the gross value of products, 57 per cent; cost of materials, 62 per cent; value added by manufacture, 52 per cent; average number of wage earners employed during the year, 44 per cent; amount paid for wages, 55 per cent; number of salaried officials and clerks, 69 per cent; amount paid in salaries, 82 per cent; miscellaneous expenses, 32 per cent; primary horse-power, 51 per cent.

There were 1009 establishments engaged in this industry in 1909 and 784 in 1904, an increase of 29 per cent.

The capital invested as reported in 1909 was $267,844,000, a gain of $93,778,000, or 54 per cent, over $174,066,000 in 1904. The average capital per establishment was approximately $265,000 in 1909 and $222,000 in 1904.

VALUE OF PRODUCTS.

The value of products was $221,309,000 in 1909 and $140,809,000 in 1904, an increase of $80,500,000, or 57 per cent. The average per establishment was approximately $219,000 in 1909 and $180,000 in 1904.

The cost of materials used was $108,566,000 in 1909, as against $66,837,000 in 1904, an increase of $41,729,000, or 62 per cent.

The value added by manufacture was $112,743,000 in 1909 and $73,972,000 in 1904, an increase of $38,771,000, or 52 per cent. This item formed 51 per cent of the total value of products in 1909 and 53 per cent in 1904. The value added by manufacture represents the difference between the cost of materials used and the value of products after the manufacturing processes have been expended upon them. It is the best measure of the relative importance of industries.

GENERAL SUMMARY, 1909 AND 1904.

	CENSUS.		Per Cent of Increase, 1904–1909.
	1909.	1904.	
Number of establishments	1,009	784	29
Capital	$267,844,000	$174,066,000	54
Cost of materials used	$108,566,000	$ 66,837,000	62
Salaries and wages	$ 69,574,000	$ 42,933,000	62
Salaries	$ 20,193,000	$ 11,091,000	82
Wages	$ 49,381,000	$ 31,842,000	55
Miscellaneous expenses	$ 23,630,000	$ 17,949,000	32
Value of products	$221,309,000	$140,809,000	57
Value added by manufacture (products less cost of materials)	$112,743,000	$ 73,972,000	52
Employees:			
Number of salaried officials and clerks	17,905	10,619	69
Average number of wage-earners employed during the year	87,256	60,466	44
Primary horsepower	158,768	105,376	51

The miscellaneous expenses amounted to $23,630,000 in 1909 and $17,949,000 in 1904, an increase of $5,681,000, or 32 per cent.

SALARIES AND WAGES.

The salaries and wages amounted to $69,574,000 in 1909 and $42,933,000 in 1904, an increase of $26,641,000, or 62 per cent.

The number of salaried officials and clerks was 17,905 in 1909 and 10,619 in 1904, an increase of 69 per cent; their salaries increased to $20,193,000 from $11,091,000, or 82 per cent.

The average number of wage earners employed during the year was 87,256 in 1909 and 60,466 in 1904, an increase of 44 per cent; their wages increased to $49,381,000 from $31,842,000, or 55 per cent.

A Correction.

In the report printed on page 1225 last week of the presentation by Mr. Edward D. Adams of a bust of Helmholtz to the American Institute of Electrical Engineers it was erroneously stated that Dr. Adolf Franke, representing the Verband Deutscher Elektrotechniker, is a director of the Allgemeine Electricitäts Gesellschaft. It should have been stated that Dr. Franke, who was a pupil of Helmholtz, is a director of the Siemens & Halske Aktien Gesellschaft.

Meetings of Boston Electric Vehicle Club.

The regular weekly meeting of the Boston Electric Vehicle Club was held at the House of Edison Light, in Newton Center, Mass., at noon on Nov. 15, forty-five persons being present as the guests of the Edison Electric Illuminating Company of Boston, the host being General Superintendent W. H. Atkins. The party formed at the Edison Building, on Boylston Street, Boston, and were conveyed 8 miles in twenty-four electric automobiles through the Back Bay to Newton Center, no gasoline machines or other means of conveyance being employed. The movement of so many electric vehicles through the streets in order attracted much attention, and extended newspaper accounts of the affair were published on the following evening and morning. All of the seventeen agencies for electric vehicles in Boston were represented. Luncheon was served shortly after the party arrived in Newton Center, where full opportunity was had to inspect the bungalow.

At the conclusion of the luncheon Permanent Chairman Day Baker, General Vehicle Company, Boston, presided over the business meeting. Brief addresses were made by Mr. Converse D. Marsh, New York, and Mr. Frank J. Stone, Boston. The latter is chairman of the committee on the banquet to be given by the Electric Vehicle Club in December to various state and municipal authorities at the Boston City Club, and he announced that at this dinner an address will be given by Mr. Hayden Eames on "The Electric Vehicle," amply illustrated. A feature will be the exhibition of two photographs of a street section, showing the same traffic handled by horses and by electric vehicles, with emphasis upon the great reduction in congestion and space required brought about by the electric vehicle. The view is to be taken from the top of a high building downtown. Mr. P. R. Moses, manager of the Boston 1912 Electric Show, announced that the Electric Vehicle Association of America will maintain a model garage in the Mechanics' Building during the exhibition, and it was also stated that the Boston Edison Company had offered a complimentary headquarters space to the Electric Vehicle Club. The offer was accepted by unanimous vote. Mr. George D. Luther, Denver representative of the Edison Storage Battery Company, described the recent development of the electric vehicle in the Colorado capital, touching upon the popular interest aroused in the recent parade, in which 300 electric conveyances were in line, even the police officers forsaking their usual mounts in favor of the electric runabouts.

On Wednesday, Nov. 22, a meeting and luncheon of the Electric Vehicle Club were held at the Edison Building, with Mr. Day Baker in the chair. About fifty members and guests were present, and the principal feature of the gathering was an extended discussion of the widening scope of the electric automobile, as evidenced during recent long-distance tests in the East and Middle West. Mr. E. S. Mansfield suggested the desirability of establishing a motor mart for electric vehicles only in the Back Bay district of Boston to facilitate the examination of such machines by prospective purchasers. The plan was received with favor, and a committee was appointed to investigate the question.

An interesting discussion followed the reading of two logs of trips by electric automobile from Boston to New York. One was made in 1903 in four days five hours one way and two days thirty-two minutes the other. The second and recent trip was made by Mr. W. H. Francis, purchasing agent of the Boston Edison company, and Col. E. W. M. Bailey, of the S. R. Bailey & Company electric-vehicle organization, Boston, and extended over forty and one-half hours' total time, the actual running being at the schedule speed of 20 miles per hour for the 244 miles. The machine made the trip on 2.59 amp-hours per car-mile. As a result of the successful trip, combined with other investigations, the Boston Edison company has ordered six additional electric machines of the same model, to replace gasoline cars. Mr. Francis emphasized the fact that the Edison company found itself obliged to secure an electric automobile which would make an average speed of 20 miles per hour on roads typical of those in the Boston district, in order to discard the gasoline cars and high-priced chauffeur service required for suburban operation.

Mr. H. H. Rice, president of the Waverley company, Indianapolis, Ind., addressed the club at length upon the proper sphere of the electric pleasure and mercantile vehicle. He cited a run made through four states in the Middle West, in which an electric vehicle made 1400 miles in twelve days, finishing only a day or two behind the gasoline touring cars for which the run was primarily planned, and pointed out that such tests are chiefly of value in indicating the durability, reliability and speed capabilities of the electric machine. At the same time he contended that the electric machine is as yet unsuited for touring-car service in the hands of the public, and urged that care be taken to avoid giving the impression from such long-distance tests that the electric vehicle had become the last word in cross-country travel. He commended the policy of the Boston Edison company in standing behind the campaign in Massachusetts, and said that in his opinion Boston is the center of a great revival of electric-vehicle applications.

Electric Vehicles in Front of the House of Edison Light at Newton Center, Mass.

Mr. W. H. Blood, Jr., president of the Electric Vehicle Association of America, reviewed the transactions of the board of directors at the New York meeting of Nov. 21. He exhibited a broken steering shaft which had just come to hand as an object lesson of the need of improved designing and construction. Mr. Converse D. Marsh, New York, conceded the need of better construction, but contended that the gasoline car is in far worse straits, judging from close observation of equipment failures in garages in many parts of the country. In closing, Mr. Blood urged the publication of a vest-pocket card map of the State, showing the location of charging stations—information which is lamentably absent so far as most vehicle owners are concerned. Mr. Alexander Churchward, New York, called attention to the progress of the industry as evidenced in the fact that the vehicle which made the Boston-New York run in 1903 was equipped with two 1200-watt motors,

while the machine which made the 1911 run was driven by a single motor of 1500 watts rating. He argued that the electric vehicle has now reached the point where it can surpass the small gasoline car in economy of operation for the commercial traveler's service, in spite of the fact that the first cost of the electric may be twice that of the gasoline machine.

On account of the moderate speed which is required, the maintenance of the electric machine will be less than that of the gasoline; the opportunity for excessive depreciation through "joy riding" is absent on account of the limitations of battery service, and speeds are now sufficient for all reasonable purposes. Mr. Baker pointed out that the electric automobile will now maintain the maximum safe speed at which cars can properly be operated on the public highways, and predicted a great increase in its use as legal restrictions on fast service become more pronounced. Mr. Marsh, in closing, called attention to the attractive field for small electric-vehicle operation in central-station utility service.

Meeting of Electric Vehicle Association of America.

The regular monthly meeting of the Electric Vehicle Association of America was held in the Engineering Societies Building, New York, Nov. 21. The topic considered and discussed was "Has the Electric Vehicle Fully Arrived?" a paper on this subject having been prepared by Messrs. T. C. and K. G. Martin.

From the result of a canvass made by one of the authors it was apparent that only a small percentage of the central stations are encouraging a business from which they might and could derive a large increase of gross and net income. Judged on this basis, the authors confess that the electric vehicle has not yet got fully started, much less fully arrived. They cited the splendid evolution of the gasoline machine and the rewards attending the pioneer work undertaken by the builders of such machines as indicative of the results which should come from similar endeavors on the part of electric-vehicle builders. The latter, however, could profit by noting the scrap-heap of the former.

Citing numerous faults in design or rather in detail which they had personally experienced, the authors still proclaimed their faith in the ultimate triumph of the electric machine. In this they were encouraged by the performance of commercial cars characterized by wheel-steer, single-motor and double side-chain drive. Vehicles of this type have been in service for two years under heavy overloads, and the total average cost of tires, batteries and energy per mile was 6.58 cents, the energy being purchased at 4 cents per kw-hour. The authors drew attention to the need for a convertible vehicle offering weatherproof protection which is instantly available at any time. They also touched upon the advantages of standardization, and lamented the absence of data and curves in regard to any other feature of the industry except battery input and output.

Although authentic government figures will not be available until 1914, inquiry shows the value of electric-vehicle output at the present time to be $40,000,000, while some authorities place the figure in excess of $50,000,000. While this indicates a healthy and steady growth worthy of warmest admiration, it does not in the estimation of the authors engender a belief that the electric vehicle has fully arrived.

The paper was well received and the discussion following was participated in by Messrs. Frank Smith, United Electric Light & Power Company; H. H. Rice, Waverley Company; H. F. Thomson, Massachusetts Institute of Technology; C. Y. Kenworthy, Rauch & Lang; Thomas Appleton, Acme Garage, New York; E. S. Foljambe, *Commercial Car Journal;* W. E. Curtis, Jr., General Vehicle Company, and W. P. Kennedy, consulting vehicle engineer.

Electric-Motor Control.

Five patents recently issued to Mr. H. Ward Leonard relate to electric-motor control, and are notable for the early date of application and the breadth of claims. The principal patent of the group is based on an application filed in 1901, while another patent rests on a division of this application. The other applications were filed in 1905 and 1906. There are eighty-eight claims in the patent based on the earliest application, and 62, 30, 88 and 111 claims respectively in the other four.

The patents include broad claims on regenerative methods, especially for alternating currents, on single-phase traction and on multiple locomotive control; also on various systems of voltage speed control applying to the operation of reversible rolling mills, mine hoists, turret turning, etc.

The earliest patent in date of application includes a claim on regeneration, covering the case of the moving load producing electrical energy of different emfs, which are transformed into electrical energy of practically constant emf; also a claim on a method of accelerating and retarding a moving vehicle, supplying while accelerating alternating-current energy at practically constant emf, deriving therefrom electrical energy at variable emf, the speed of the vehicle being varied by varying the variable emf supplied to at least one element of electric motors located in different vehicles of the train, the retardation being accomplished by transforming the energy represented by the moving load into alternating-current energy and supplying said energy to an energy-consuming device.

Another claim in this patent is on a method of operating an electric motor at varying speeds, which consists in supplying its armature from a generator, exciting the field of the generator from a separate source of emf, and varying the emf of said separate source. A broad claim is on a method of operating an electrically propelled train comprising one or more vehicles, consisting in generating high-tension, single-phase energy, conducting the same upon the train, and there transforming it into energy of sufficiently low tension to be regularly commutated, dividing said energy and supplying each division to at least one element of its respective electric motor, commutating the current of each division and varying the speed of the train by varying the net effective emf of the low-tension energy. One claim relates to a method of controlling an electrically propelled train comprising a plurality of vehicles, consisting in producing on one of the vehicles an emf for producing a current in a controlling circuit, transmitting the current to another of the vehicles, and controlling from that vehicle the current in the circuit, and thereby controlling the movement of the train. A broad claim relates to a method of operating a train consisting in generating electrical energy at a stationary source, transmitting the same to the train, leading it upon the train by means of moving contacts, transforming the energy into a plurality of divisions on different locomotive units of the train, supplying said divisions of the energy to at least one element of the respective locomotive units and simultaneously controlling the transformed energy to control the train.

Another claim is on the method of controlling a plurality of motors acting on a common load, which consists in simultaneously controlling a plurality of inductively acting voltage regulators in series with each of the motors respectively. Still another claim is on the method of controlling a plurality of electrically propelled vehicles in a train, consisting in generating alternating-current energy, accelerating the vehicles by energy derived therefrom, generating alternating-current energy to retard the vehicles and supplying this energy to the circuit, transmitting controlled energy along the train and controlling the latter for producing the acceleration or retardation. One claim is on a method of electrically controlling a multiple train, consisting in generating electrical energy upon each of a plurality

of the locomotive units, dividing the total duty of each of the locomotives between a plurality of motor armatures, and varying the energy supplied to each of the motors by varying the controlled energy supplied to the plurality of units. Electropneumatic and hydraulic control are included in two general claims, one of these being on a method of multiple train control, which consists in transmitting controlled energy along the train, said energy having a variable factor, and varying the value of said factor of the controlled energy upon each of the units to vary the speed of the train.

A patent for which application was filed July 12, 1905, relates largely to the use of auxiliary voltages. One of the claims is on a method of varying the emf of a work circuit, consisting in successively impressing upon said circuit a plurality of different voltages and supplementing said impressed voltages by auxiliary voltages variably and uninterruptedly from approximately zero to approximately the potential difference of said impressed voltages. Another claim is for a system of control for electrical apparatus, including a source of multiple voltage energy, a regulating auxiliary gradually variable emf-producing device, and a means for including said regulating device in the circuit of the electrical apparatus in changing from one voltage to another. Still another claim is on a subdivided transformer, an emf-producing device and a translating device, together with means for connecting said device between points of subdivision of the transformer, for connecting the same in series with a portion of the transformer winding, and for cutting the latter device out of the circuit of the translating device.

In a patent granted on application filed Dec. 7, 1905, methods are claimed for controlling an electric motor, consisting in generating a plurality of different emfs and subjecting the motor directly to each of these and to intermediate emfs by developing in series with the motor a variable and reversible emf; on producing two unequal emfs in series with each other, and successively impressing each of these upon a circuit containing a translating device and further controlling the energy in the circuit by variable emf; on a combination of a multiple voltage system, the voltages between each successive pair of mains being different, a translating device, an auxiliary source of variable emf, a means for connecting the translating device successively to the supply circuit of the multiple voltage system and to the auxiliary source jointly; on the combination of means for unsymmetrically dividing the source of electrical energy so as to produce different emfs, the means comprising a winding producing by magnetic induction a variable emf, an electric motor, and a means for connecting the armature of the motor to said winding in series with each other, so as to be subjected to either or both of said different emfs.

In a patent granted on an application filed March 16, 1906, there are claims on a method of controlling a plurality of electric motors, which consists in supplying multiple voltages in series with each other and connecting the motor armatures in series and in parallel across the different voltages; on a method of controlling a plurality of electric motors acting on a common load, which consists in supplying field-exciting currents in parallel with each other, varying the strength of the currents and supplying armature currents in series, in multiple series and in multiple; on the combination of a plurality of motors acting on a common load, and means for connecting the motors in series, connecting certain of the motors in parallel, and for causing certain of the motor armatures to generate current to retard the load. A broad claim is on a stationary alternating-current source of energy, an electrically propelled vehicle supplied with energy therefrom through two moving contacts, means on the vehicle for developing a plurality of different voltages, a plurality of propelling motors, and a means for connecting one element of certain of the motors across the different voltages for controlling the movement of the vehicle. Still another claim of this character is on the combination of a high-tension source of electrical energy, a moving vehicle supplied with energy therefrom through moving contacts, a multiple voltage system supplied from said source and carried by the vehicle, a plurality of propelling motors, and a means on the vehicle for connecting the windings of said motors across the different voltages of said system and for transferring said windings from one voltage to a higher voltage.

A patent based upon a division of an application filed Jan. 24, 1901, is on a multiple-control system. One of the claims is on a motor-control system, comprising a source of alternating-current energy, an alternating-current circuit leading therefrom, an electric motor, energy-transforming means adapted to receive energy from said circuit and deliver energy to a winding of the motor, a control circuit, separate source of emf supplying said control circuit, and a means for changing the emf supplied by said source to said circuit. Another claim is on a system of motor control, comprising a motor, a generator supplying the armature of said motor, an exciter for the generator field, and means for varying and reversing the field strength of the exciter. Still another is on an alternating-current supply circuit, electric motor, transformer supplying energy to a winding of said motor, and a motor-controlling means comprising an additional energy transformer.

New Mexican Hydroelectric Plant.

One of the largest electric power projects in Mexico is that of the Compañia Hydro-Electrica Mexicana, S. A., which was recently formed with a capital stock of $30,000,000. It proposes to install hydroelectric plants upon the Rio Blanco in the States of Nuevo Leon and Tamaulipas and on the Rio de los Marangos in the State of San Luis Potosi, the company having already acquired concessions from the federal and state governments for these proposed plants. It expects to develop about 60,000 hp, which it will transmit to Monterey, Tampico, San Luis Potosi, Victoria, Montemorelos, Linares and other towns, covering a big scope of territory in northern and central Mexico. This electricity will also be used to operate electric railways in Monterey, San Luis Potosi and Tampico. Tentative contracts for the use of this power have already been made with many industrial plants in the different towns that are to be served. The surveys for the necessary dams and transmission lines are now being made. The officers of the company are: President, Mr. Thomas Makinson Sanders; vice-president, Mr. Frederick James Robinson; treasurer, Mr. Thomas Phillips; manager, Mr. José Romero, and secretary, Mr. Manuel Migoni. It is stated that construction work will be started on the different plants within the next few weeks and that it is expected that electric energy will be available within the next twelve to eighteen months.

Electrical Engineering Future Possibilities.

The Schenectady Section of the A. I. E. E. held its first regular meeting for the season of 1911 and 1912 at Redmen's Hall, Schenectady, on the evening of Nov. 8, 1911, at which time Mr. Henry M. Hobart, consulting engineer of the General Electric Company, read a paper entitled "Some Simple Dormant Possibilities in Electrical Engineering."

Mr. Hobart, in referring to the increasing use of induction generators and motors for very high speeds, called attention to the difficulties encountered in the design of 60-cycle steam turbo-driven synchronous generators above 3000-kva or 4000-kva output, which difficulties are greatly modified when the induction generator is used. Synchronous generators and motors are specially suitable for

low speeds, while induction generators and motors are high-speed machines.

The advantages were pointed out of winding generators for low voltage and employing step-up transformers between generators and transmission-line or cable systems, this practice being the outgrowth of the successful manufacture of cables for voltages above 11,000 volts and the difficulty in insulation and mechanical support of end connections in high-voltage generators. The paper showed the advantage of employing 60-cycle static rectifier substations instead of 25-cycle rotary converter substations for electric railway operation, thus rendering feasible the use of 60-cycle transmission, and referred to the possibilities of decreasing the capital cost and at the same time improving the "all-year" efficiency of rotary-converter substations by increasing the average load on the rotary per rated horse-power. Other points brought out were in relation to improved methods of cooling electric machinery by the use of ducts parallel to the shaft through the core, through which air is forced which carries a large quantity of water in suspension; the advantages from the use of the internal-combustion engine for isolated plants as contrasted with the present practice of large centralized plants, with the unavoidable large layout of capital for transmission; gasoline-electric propulsion, and electric propulsion of ships.

The paper of Mr. Hobart was discussed by Messrs. D. B. Rushmore, E. A. Baldwin, F. W. Peek, A. H. Kruesi, L. R. Robinson, F. P. Coffin, C. J. Hixon, C. McMillan and J. R. Werth.

Shop Testing of Electrical Apparatus.

At a meeting of the Pittsburgh Section of the A. I. E. E. on Oct. 14 a paper on the shop testing of electrical apparatus was read by Mr. E. M. Olin, who has charge of the testing department of the Westinghouse Electric & Manufacturing Company.

The author emphasized the importance of testing and its value to both user and maker, saying that tests are made primarily for two reasons, namely, to demonstrate the design and to prove the quality and workmanship of the apparatus. The design of electrical apparatus is based primarily on theoretical formulas, but the designer would be helpless without the use of constants derived from and based on extensive tests under actual operating conditions. Tests have been conducted over a period of many years, and it would seem as if they would become so standardized that it would not be necessary to repeat them, but designs change so frequently that it is necessary to continue tests and make new ones all the time. As an example of this may be mentioned the commutating pole, which is rapidly rendering the non-interpole machine obsolete and has revolutionized testing direct-current machines. Turbo-generators have produced the same results.

The expense of operating a testing department is an important item and one which is often not appreciated by the management as a part of the production costs, which it really is. It costs about ten times as much to correct errors in the field as it does on the test floor, and thereby the testing department often pays for itself many times over.

The speaker stated that it is the policy of the Westinghouse Electric & Manufacturing Company to test every piece of apparatus as nearly as possible under actual operating or service conditions in an endeavor to ascertain its behavior under these conditions. A company frequently suffers not only financial loss but loss of prestige by failure of apparatus which might have been prevented by thorough tests. The range of output, voltage, speed and frequency in the apparatus to be tested means a large expense to secure and maintain. As an example it may be necessary to test an 80-volt direct-current vehicle motor and at the same time a three-phase, 6600-volt synchronous motor. It is, therefore, necessary to have available direct current at all emfs from 0 to 1500 volts and alternating current of all frequencies, phases and voltages.

Electrical apparatus is sold under guarantees, and the object of the test is to see that it meets these guarantees. Temperature, efficiency, power-factor and similar guarantees must all be proved by the test. Temperature calculations are made either by the fall-of-potential or the bridge method. Tests by thermometers, however, are usually preferred by engineers when it is possible to make them, and this is borne out by the recommendation of the standardization committee of the A. I. E. E.

Mr. Olin described briefly the methods used for testing generators, motors, transformers and various other types of apparatus. He stated that 95 per cent of the troubles experienced with direct-current machines are with the commutators, and they are the most difficult to overcome from a mechanical standpoint owing to the high bars, soft spots and other faults. To correct these, they are run on short-circuit—often external heat is applied—and then the bolts are tightened, the commutator is trued up and the machine again run at normal speed. This process is often repeated six or eight times and is, naturally, a very expensive operation. It often seems, said the speaker, that direct-current machines are like individuals and are subject to good and bad spells and must be treated accordingly.

The testing department is different from all the other departments and is usually the last one to handle the apparatus, and as a result it is usually "between the devil and the deep blue sea" of the producers on one hand and the salesmen on the other. Factory tests are indispensable to engineers, for new problems are being worked out every day, as, for example, the determination of the brush setting of interpole machines.

Much trouble that is experienced in the field might be avoided if complete and accurate information as to service conditions was supplied to the manufacturers at the time of placing the order.

The paper was very widely discussed by the members present, among those taking part being Messrs. P. M. Lincoln, A. M. Dudley, A. W. Copley, R. L. Wilson and M. C. Turpin.

Ions and the Kinetic Theory of Matter.

Evidence that the kinetic theory of matter and the atomic state of electricity have received such rigorous experimental proof as to lift them out of the class of unsubstantiated hypotheses, placing them among demonstrable scientific facts, was related by Prof. R. A. Millikan, of the University of Chicago, in his lecture at Fullerton Hall, Chicago, Nov. 16, which was one of a course of winter Thursday evening addresses by Chicago University professors on "Frontiers of Science."

After pointing out the evidence contributed by the simple laws of electrolysis supporting an atomic conception of electricity, since the material transported across an electrolytic cell is proportional to the atomic weight of the element involved, Professor Millikan described briefly his own classic series of experiments in which individual atmospheric ions were isolated and their values found to correspond with the electrochemical quantity already observed. An account of this method was given in the *Electrical World* of Oct. 20, 1910, and other issues. Of the billions of billions of molecules in a cubic centimeter of air, from two to ten break up each second, probably under the action of radioactive materials in the rocks of the earth. There are thus three to four ions per cubic millimeter, and upon their presence in the air depend the phenomena of atmospheric electricity, discharges, etc. In the formation of these ions the molecules themselves are not broken up or shattered, but only a single ion "knocked off" each molecule. This

was demonstrated by observing minute oil drops in artificially ionized fields, where in no case more than a single charge alighted on the drop at a time. The so-called Brownian movements observed in small particles in liquids have already been thought to be attributable to molecular bombardment, according to the kinetic theory of matter. Professor Millikan has subjected to very low pressures the oil drops in his apparatus used to isolate ions and finds that these drops take up a dancing motion as they are impelled to and fro by collisions with the flying molecules of the attenuated gas. Negative ions are all alike, said the speaker, and weigh about one-seventeenth hundredth of the hydrogen atom. The positive ions, differing among themselves in size, are much larger, the greatest being of about the weight of the hydrogen atom. In size there is reason to believe that the negative ions are about one-one hundred thousandth of the diameter of the atoms. To keep the ordinary 16-cp electric lamp aglow, about three billions of billions of electrons per second course through its incandescent filament.

Cost of Power.

About 100 mechanical engineers, central-station men and others interested in the cost of power production convened on Nov. 15 at the new Mason Laboratory of Mechanical Engineering, Yale University, New Haven, Conn., to participate in a discussion of this topic, celebrate the opening of the laboratory and listen to an illustrated lecture by Prof. Charles F. Scott, of the department of electrical engineering, on "The Development and Public Service of the Hartford Electric Light Company." The meeting was held under the auspices of the New Haven branch of the American Society of Mechanical Engineers, Mr. E. S. Cooley, of the Connecticut Company, New Haven, being in the chair. Prof. Lester P. Breckenridge, of the department of mechanical engineering, acted as host on the part of the university, and at an evening session Col. E. D. Meier, president of the American Society of Mechanical Engineers, delivered a short address on the larger aspects of engineering co-operation through sectional work in different parts of the country.

The new laboratory is a handsome brick and steel structure recently erected at a cost of about $200,000, and its architectural features are unusual through their adaptation to a site adjoining that of a large church. Special attention has been given to the use of electricity for lighting and power in the new building. The main laboratory, about 180 ft. x 35 ft., is lighted by twenty-two 250-watt tungsten lamps hung about 35 ft. above the floor, there being about 0.87 watt per square foot available for the illumination of the testing floor, which is served by a 10-ton Shaw electric crane running from end to end. Other electrical features include a 75-kw Curtis turbo-generator, an ash conveyor driven by a 3-hp motor, a motor-driven sump pump, an electric elevator installation, and tungsten lighting in lecture-room, office, research-room and other sections. All wiring is in conduit, and the electric drive is used in the operation of a 100,000-lb. testing machine and other equipment of high and moderate power.

DISCUSSION OF COST OF POWER.

Three papers were presented on the cost of power production. Mr. A. W. Honywill presented figures covering the operation of a 45-hp gas producer plant in New Haven factory service. The first cost of the plant was $3,500, the producer being of the anthracite suction type and the engine a 4-cycle Backus equipment running at 160 r.p.m., with water-cooled cylinder, head and valves. The author found the cost of operation to be $5.55 per day with coal at $4.50 per ton, including 15 per cent for interest, depreciation and repairs. No test was made to determine the average load upon the engine, but a study of the power requirements and service of the woodworking machinery driven by it indicated that the average output for a ten-hour day did not exceed 18 hp, representing a 40 per cent load-factor. Mr. F. P. Pfleghar, New Haven, gave the results of operation of a 27-in. x 33-in. oil engine rated at 125 hp and operated by oil costing about 4 cents per gallon. The daily cost of operation was $9.68, or $43 per hp-year when fixed charges were added. The engine cost about $6,000, and 10 per cent was allowed for interest and depreciation. On account of the importance of maintaining constant service the writer stated that it was necessary to run a 90-hp steam engine in the plant at a yearly cost of $62 per horse-power, including operating expenses and fixed charges. The third paper was a discussion of the status of the small steam turbine, by Mr. W. J. A. London, of the Terry Steam Turbine Company, Hartford, Conn. The author emphasized the increasing usefulness of this type of machine in driving power-plant auxiliaries, its simplicity and efficiency under a wide range of conditions. He brought out the point that the water rate of a small turbine is not a vital consideration in view of the general use of exhaust steam for feed-water heating and the cost of even small improvements in economy when referred to the turbine design. Simplicity of operation and low maintenance costs were the chief issue.

ARGUMENTS FOR CENTRAL-STATION POWER SERVICE.

In the discussion of the foregoing papers a number of points were brought out by various speakers which tended to emphasize the benefits of central-station electric service in handling small power situations. It was shown that a lower rate had been offered for electric power at the woodworking plant operated by the producer-gas engine, the difference being about $150 per year below the total cost of service as given in the paper. It was also stated that about two hours were required for starting the producer and engine plant from the cold state, whereas the electric drive is always ready for instant service. In the case of the oil-engine plant the owner stated that great trouble had been experienced on account of the expansion and contraction of the metal in the engine, requiring frequent replacements of caps of cylinders, two or three per year, and at a high cost. Twenty minutes is required for heating the engine before placing a load upon it; the cost of maintenance is higher than with steam, and the direct connection of the engine and generator results in a service at the motors which is rather uneven on account of the jar of the engine operation. From four to five hours are required for cleaning out the interior, and if anything goes wrong nothing can be done until the machine has cooled down. Trouble has been experienced with the muffler, and the owner has never been able to obtain over 90 hp from the engine, which is less than its normal rating. The cost of the steam reserve is also serious. The point was also made that the installation of electric motors to replace the foregoing equipment would mean reliable service in any quantity required by the plant expansion, and at a rate of depreciation which would add merely a nominal cost to the total running expenses.

DEVELOPMENT OF HARTFORD ELECTRIC LIGHT COMPANY.

Professor Scott reviewed the physical changes in the plants of the Hartford Electric Light Company from 1883 to date, showing the types of equipment which were tried out at various periods and the growth of the business and earnings. Many diagrams were given showing the changes in rates, expenses, revenues, generating and distribution methods. Since 1901 the company's earnings from residence lighting have increased 500 per cent; from commercial power sales, 410 per cent, and from commercial lighting, 210 per cent. In 1902 the total annual output was 11,000,000 kw-hours, and in 1910 35,000,000 kw-hours. The maximum meter rate has dropped from 17 cents in 1894 to 10 cents at present. In 1901 the proportions of the total earnings were as follows: Street lighting, 17 per cent; residence lighting, 7 per cent; power, 22 per cent; commer-

cial lighting, 54 per cent. In 1910 these proportions were 6.5, 13.5, 36 and 44 per cent respectively. The average earnings of the company were 4 cents per kw-hour in 1901, compared with 2.6 cents at present. Meter rates for power now run from 6 cents to 1.33 cents, the lowest rates being given to installations of about 300-hp capacity or over, operating at about this load for at least ten hours daily. In 1895 the company had twenty-four generators rated at 1050 kw total, compared with ten rated at 16,500 kw to-day. Professor Scott stated that practically every isolated plant in Hartford has yielded to the superior economy of central-station service. About 6000 homes are supplied with light by the company, half of these being served at 60 volts on a flat rate. The pioneer experiments of the company with fireless cookers were touched upon, and the speaker closed with a high tribute to the consistent progressive policy which has been maintained for twenty-five years by President A. C. Dunham in the development of a central-station service quick to make use of advances in the art, careful to secure the benefits of economical operation and alert to give the public a better commodity for its money than was available before the central-station organization attained its present status.

Turin International Congress—III.

Instruments and Methods of Measurement.

In Section III of the Turin International Electrical Congress fifteen papers were presented, dealing with instruments and methods of measurement. Abstracts of these papers follow:

WATT-VOLT-AMPERE METERS.

By producing a certain phase displacement between the shunt and series currents of a wattmeter Prof. Riccardo Arnò obtains an instrument which gives the approximate product of volts and amperes. In order to make this instrument practicable he divides all commercial circuits into two classes, namely, lighting circuits with a power-factor from 1 to 0.85 and motor circuits with a power-factor from 0.9 to 0.5. He then chooses an average phase displacement for each class of measurement and provides a means of shifting the wattmeter circuits from one to the other.

Mounting two wattmeters in one case with their pointers crossed and one wattmeter adjusted to read volt-amperes while the other reads watts, the intersection of the pointers is an indication of the power-factor, and a suitable scale enables power-factor to be read directly.

THE ROTATING ELECTRIC-CURRENT FIELD.

Dr. A. E. Kennelly describes in detail the method for producing alternating-current vector diagrams experimentally which was outlined in an article in our issue dated March 30, 1911. In appendices were discussed methods for estimating the error in the current-sheet distribution due to the fringe of connecting wires on each edge; the conditions for maximum precision in measuring an impedance vector diagram on the conducting sheet, and methods for the determination of the current locus of balance points on the rotary-current sheet with diametral taps to a coil and variable additional resistances in its circuit.

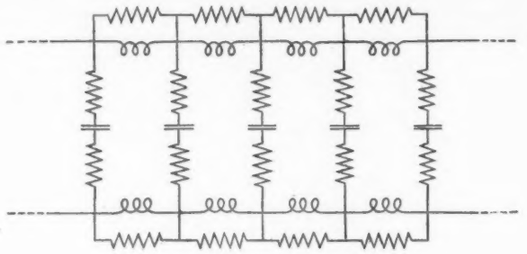
USE OF POLAR DIAGRAM IN DETERMINING THE MEAN EFFECTIVE CURRENT.

In a comprehensive paper on the subject of determining the mean effective curent Mr. C. O. Mailloux called attention to the time and labor saving incident to the use of the polar diagram and demonstrated its value by actual examples relating to unidirectional currents.

HIGH-FREQUENCY SURGES.

After briefly reviewing the methods of propagation of high-tension oscillations along a transmission line Mr. Gino Campos pointed out various practical ways of dissipating harmlessly the energy of such oscillations.

Basing his assumptions on experimental work done in telephony and wireless telegraphy, he expressed the attenuation constant in terms of the line resistance, the leakage conductance, the line capacity and the line inductance,



Arrangement of Protective Circuits.

according to the usual equation, and then proceeded to modify these different quantities so as to dissipate high-frequency energy but not disturb the low-frequency energy being transmitted over the line.

High-frequency current being forced toward the periphery by skin effect, it is practicable to cover the wire with a very thin layer of high-resistivity metal and thus increase the high-frequency resistance enormously. Experiments at the Reichsanstalt showed that a wire covered with a layer of nickel 0.07 mm thick offered four times as much resistance to 300,000-cycle current as did a bare wire of the same size.

Another method is to use an inductance coil in series with the line and shunt it with a resistor. The normal line current will pass through the inductance coil, while the high-frequency currents will take the shunt path and become largely dissipated in resistance. This arrangement was tested with favorable results at 450,000 cycles per second. A third method seeks to increase the dissipation of energy by connecting condensers in series with resistors across the line. However, the most effective method results from a combination of the foregoing as in the diagram. An arrangement of this sort should be placed at points along the line where protection is desired. The values of resistance, leakage conductance, capacity and inductance are so proportioned as to eliminate reflection of the waves of any frequency.

Tests on an arrangement of this kind showed that the surge potential decreased to one-third at 50,000 cycles; to 7 per cent at 100,000 cycles; to less than 1.3 per cent at 200,000 cycles, and to about 0.5 per cent between 500,000 and 1,000,000 cycles.

Much of this high-frequency energy is also dissipated in electromagnetic radiation, but little is known of the resistance and conductance of radiation, so that no attempt has yet been made to utilize this phenomenon for protective purposes. The author suggested that it would be desirable to construct a miniature line for the study of these phenomena much as Steinmetz did in studying surges produced by switching.

The paper was discussed by Messrs. del Buono, Faccioli, Olivetti and Gola.

PROTECTIVE DEVICES.

Mr. Guglielmo Neuhaus described an apparatus for protecting low-tension circuits from dangers incident to crosses with high-tension circuits. Protection of the user of low-tension apparatus demands that in event of a cross the high-tension circuit must be opened and the low-tension circuit grounded.

The apparatus described was for a three-phase system, but it may be adapted to any number of phases. In the low-tension three-phase system there are five fuses connected, one from each wire to ground and the other two between one wire and the other two. The operation of

these fuses actuates a relay which closes a transformer circuit, which in turn furnishes current to open the high-tension circuit and ground the low-tension circuit as well as sound an alarm.

In a second paper the same author called attention to the fact that, while considerable progress had been made in the development of apparatus for protecting machines, practically no thought had been given to the protection of life in case of breakage of wires or crossing of high-tension wires with low-tension wires. He then described an apparatus for short-circuiting the line in event of breakage of a wire.

ZERO METHODS IN ALTERNATING-CURRENT MEASUREMENTS.

Messrs. A. Barbagelata and L. Emanueli reviewed present practice in zero methods of alternating-current measurement. They distinguished two fundamental methods: (1) Those methods in which the phase of the potentiometer current is adjusted until it coincides with that of the potential difference to be measured: (2) those methods where the unknown potential difference is balanced against two adjustable emfs in quadrature with each other.

The phase shifters used in the first method may be of the resistance or of the induction type. The latter is preferable because the angles of mechanical displacement and phase displacement are almost identical, and there is little to fear from wave distortion.

The characteristics of various forms of current detectors are then taken up. Among the types discussed are the telephone receiver, the vibrating galvanometer, the electrodynamometer and the ordinary galvanometer with a current rectifier. The telephone is, of course, the cheapest and for frequencies between 500 and 5000 cycles per second it is extremely sensitive, but at low frequencies such as are used in the industries its sensibility is greatly reduced. The vibration galvanometer and the electrodynamometer are treated in detail, and it is shown that an electrodynamometer with its fixed coil excited by current in phase with the current in the movable coil is extremely well adapted to the purpose, having great sensibility and being easy to manipulate.

The second method of balancing may be accomplished with an adjustable mutual inductance for furnishing the component in quadrature with the potentiometer emf, or a system of two-phase emfs may be employed. In discussing the applications a special study was made of the influence of the form of the current wave. All the methods give the magnitude and phase of the fundamental; nevertheless the authors demonstrated that the result is correct when making power measurements on a circuit having practically sinusoidal emf. When using electrodynamometers for power measurements the results are always accurate, provided the exciting current in the fixed winding has the same form as that in the movable coil.

As to choice of method the authors expressed preference for the mutual inductance and the telephone receiver foi frequencies above 500, while for ordinary industrial frequencies they preferred the use of a phase shifter and an electrodynamometer. In conclusion they described a Drysdale-Tinsley potentiometer and equipment in the electrotechnical laboratory of the Polytechnicum at Milan and gave examples illustrating its application in calibrating voltmeters and wattmeters and in testing instrument transformers.

MEASUREMENT OF INSULATION RESISTANCE OF ALTERNATING-CURRENT LINES.

A method of determining the insulation resistance of a circuit from tests made while in operation was communicated to the congress by Mr. Alberto Dina. The author briefly reviewed the work of several others on the same subject and showed the limitations of their methods. He then proceeded to develop various graphic methods which are perfectly general in their application. The first series of methods assume that the capacity to earth is known. Examples are given for single-phase and three-phase currents using two different methods. One method assumes that the measurements are made with an electrostatic voltmeter and the other that they are made with a voltmeter which consumes current. Following the discussion of these methods, the case where the capacity is unknown is taken up. These methods require one electrostatic voltmeter and one current-consuming voltmeter, one electrostatic voltmeter and a resistor, or two current-consuming voltmeters having different constants. Examples are given for each method.

In every case the charging current of the electrostatic voltmeter is assumed to be negligible in comparison to the leakage current through the insulation. In cases where the error introduced by this assumption is objectionable the author suggested that a suitable impedance coil be connected between the line under test and the earth, and that a correction factor in terms of the inductance and resistance of the impedance coil be applied.

PREVENTION OF OSCILLATIONS DUE TO SWITCHING.

In a second communication Mr. Alberto Dina described two methods of preventing large rises in voltage due to oscillations produced by manipulation of the main switches. In the first method, assuming a single-phase system, a resistor in series with a spark-gap is connected across the line side of the switch, and the junction between the resistor and the gap is connected to an auxiliary switch mechanically locked with the main switch and electrically connected in series with one side of the main switch. In operation the auxiliary switch closes first, thus connecting the resistor and cable network in parallel, and when the main switch is entirely closed the auxiliary switch is open, thus disconnecting the resistor from the circuit but leaving it always in series with the discharge gap across the line.

The approximate value of this resistance is determined by neglecting the inductance of the cable system and assuming the capacity to be concentrated at one point; then to avoid oscillations upon closing the circuit, the value of the resistance should not exceed the critical value

$$R_c = \tfrac{1}{2}\sqrt{\frac{L}{C}}$$

wherein L is the inductance of the generator and C the capacity of the cable system. However, the fulfilment of these conditions only meets the requirements of the first part of the operation. Upon closing the switch completely, a short-circuit across the spark-gap is opened and oscillations will be established unless

$$R > 2\sqrt{\frac{L_c}{C}}$$

wherein L_c is the inductance of the cable circuit (neglected before) and C the capacity of the cable.

In some cases both conditions cannot be perfectly met, but the value of R is allowed to exceed R_c. The author showed a curve giving the first and second maxima of the emf rise as a function of R/R_c, and according to this for $R/R_c = 2$ the first maximum would be about 15 per cent above normal and the second would be entirely negligible. However, the increase is very rapid and for $R/R_c = 5$ the first maximum reaches 50 per cent, while the second is 15 per cent. This same connection is also well adapted to main switches in substations between the cables and the transformers.

Mention is also made of special switches which are provided with a series resistor that is first connected in circuit and then short-circuited. These switches are used both in generator-feeding cable systems in overhead lines and also in substations between the line and the transformers.

INTEGRATING METERS.

Beginning with the legal requirements as to the accuracy

of meters in different European countries, Mr. A. Durand discussed the errors in different types of watt-hour meters and ampere-hour meters, calling attention to the shortcomings of the various types and suggesting how they may be improved.

Meters should always be tested with their covers on, since the temperature of the working points is due more to the heating action of the losses in the meter than to outside causes. The permissible losses in France are high, namely, 4 watts per 10 volts in the shunt winding and 1 volt drop across the series winding of commutator meters. Therefore the total loss in a 110-volt, 10-amp meter is about 15 watts at full load. The shunt winding alone will produce a temperature rise of 10 deg. C., and when operating at full load the temperature rise may reach 25 deg. C. The rise in temperature decreases the driving torque and also the damping torque; therefore, theoretically the error can be eliminated, but in actual practice it seldom is less than 1 per cent per 10 deg. rise, and may even reach 4 per cent. Induction meters are affected to a much less degree by temperature changes than are commutator meters when the damper and the exciting winding both react upon the same disk. The error in such meters is about 1 per cent per 10 deg. C. Friction due to brushes, pivots or both presents a serious difficulty. Tightening the brushes may cause an error of 10 per cent at one-tenth load, and a short-circuit between two bars may cause a retardation of 10 per cent at full load and stop the meter entirely at light load. Relatively heavy movable systems and high speeds cause rapid wear and increase in friction. Cases were cited where jewels had to be changed once a month.

Much trouble experienced with meters is laid to dirt, and the author intimated that a perfectly dirtproof case would do much to improve the performance of the instruments. The effect of external fields is often quite considerable. An instance was cited of two 300-amp Thomson watt-hour meters placed on 9½-in. centers. When one operated at full load the other showed an error of 10 per cent at one-tenth load and 20 per cent at one-twentieth load. Induction meters are much better shielded from the action of external fields.

In discussing the effects of short-circuits oscillograms of tests under various conditions are shown. The demagnetizing effect of the short-circuit current may be lessened by properly designing and placing the magnets. The use of a shield is not advisable, since the shield itself becomes magnetized and reacts upon the movable coil.

The use of shunts is recommended for direct-current meters, care being taken to compensate for temperature errors. Shunts for alternating-current meters must have the same time constant as the winding they are connected across. Creeping may be caused by fluctuation in emf, by external magnetic effects, or by action of a shield magnetized by a short-circuit. Considerable errors were noted in induction meters subjected to variable frequency and bad wave distribution. Variations of 5 per cent in the frequency produce an error at one-half load of from 1 per cent to 2 per cent. An instance is cited where a meter registered correctly when the circuit was supplied from a certain generator and showed an error of 15 per cent when a generator of different wave-form was connected to the line.

Low power-factors tend to make Thomson meters run fast. Induction meters can be almost perfectly compensated for power-factor. Defective construction is largely responsible for the necessity of testing meters in position. The author stated that at least half of the commutator meters record too little at light loads. Tests in position are less accurate than in the laboratory, and therefore the permissible errors are about double the laboratory values in both France and Germany.

Of all the meters that have been tested at the Laboratoire d'Électricité, 14.3 per cent of the commutator watt-hour meters, 40 per cent of the commutator amp-hour meters and 47 per cent of the induction watt-hour meters satisfied the official tests. The rest had to be adjusted or changed in order to bring them within the limits. The author concluded by deprecating the practice of standardizing laboratories in issuing certificates of accuracy to within one-ten thousandth or even one-one thousandth. The methods of measurement, and above all the meters themselves, do not permit this degree of accuracy.

PRACTICAL CALCULATIONS OF ELECTROSTATICS.

In a communication entitled "Practical Calculations of Electrostatic Fields" Prof. Vladimir Karapetoff declared himself in favor of the Giorgi system of units on the ground that it is more logical and that it facilitates the physical interpretation of formulas. After briefly reviewing Faraday's conception of the electric field, he adopts the terms "permitance," "elastance," "permitivity" and "elastivity," introduced by Heaviside, to replace "capacity," "specific capacity" and their reciprocals. The unit of elastance is denoted as "daraf," which is "farad" reversed, being the reciprocal of "farad." Having adopted these units and this nomenclature, the author proceeds to write the equations for permitance, elastance and other quantities dealt with in electrostatic calculations, following which he gives numerical examples of practical calculations that serve to demonstrate the simplicity and convenience of the system.

ELECTRICITY METERS.

Dr. Clayton H. Sharp presented an outline of American meter practice, which has been influenced by certain important factors that have tended to differentiate this practice in some respects from that of other countries. The practice at the present time is the result of co-operative effort on the part of the meter manufacturers and the committees of the National Electric Light Association and the Association of Edison Illuminating Companies. Confidential information and technical data are freely exchanged, to the great advantage of both the manufacturing companies and the electrical associations. The manufacturing companies become intimately acquainted with operating conditions and with such shortcomings of existing apparatus as develop in practice, and are thereby better able to introduce improvements in their products, while the operating companies gain a valuable insight into the problems and conditions of manufacture and the requirements of standardization. As a result of this co-operation there has been brought out by the committees of the two associations a standard code comprising sections on general topics of measurements, on specifications for acceptability of types of meters and of auxiliary apparatus, and on methods of installation, tests and maintenance of meters. Certain of the improvements which have been introduced in meters during the last few years were outlined. There exists at the present time a very strong demand for a meter low in first cost and maintenance and which has at the same time great reliability in operation and a reasonable degree of accuracy. This condition indicates the possible return to the ampere-hour meter in some form which may be found to meet the requirements of the case. At the present time, however, for the purpose of metering the direct-current energy sold, the watt-hour meter of the motor type has practically universal sway. The moving element has been greatly reduced in weight, to the advantage of permanent accuracy of registration. By the use of aluminum instead of copper disk, and by the use of a spherical armature, designed to give the highest torque per unit weight, the result is that with 25 per cent less copper there is 35 per cent more torque. The most important improvement has been in the jewel used in the step bearing. Cut diamond jewels produced by automatic machinery are used very extensively in the direct-current meters. For alternating-current energy measurement the induction type of meter is more re-

liable and satisfactory than the commutator meter which has been employed to some extent for this purpose. For metering polyphase energy use is made of a single meter consisting of two metering elements, which are for all practical purposes independent of each other. The size of meters selected for any installation is chosen rather too small than too large. Meters in use are very carefully tested periodically in the laboratories and on the customers' premises and are thereby maintained in a state of satisfactory efficiency, the expense incurred being more than returned by the increased revenue derived from the accurate meters.

The paper was discussed by Mr. Torchio, who gave some statistical data from the Edison Illuminating companies.

HIGH-TENSION SWITCHING PHENOMENA.

In a paper by Mr. G. Faccioli were described a series of tests performed on the 100,000-volt transmission lines of the Central Colorado Power Company for the purpose of studying line oscillations produced by the operation of high-tension oil switches. The results showed that each switching operation may produce several complex successive oscillations. The over-voltages produced were found never to exceed 40 per cent of the normal maximum value of the emf, which result is in conformity with theoretical considerations. An element of danger to high-tension apparatus was found in the possibility of producing local high-frequency, high-voltage stresses.

The author claimed that the common method of protecting transmission systems, by lightning arresters connected in series with a spark-gap, does not safeguard the apparatus from high-frequency impulses, although it is effective when a high difference of potential is produced between the phase conductors and between conductors and the ground. High-tension switching, which gives origin to the high-frequency impulses, should be avoided or reduced as much as possible.

When a new line is to be energized two methods of switching may be followed : First, the high-tension line, which is open at the distant end, is connected to the transformers at the generating station, and then the step-down transformers are connected to the distant end of the line. According to the second method, the step-down transformers are connected to the end of the dead line, and then the step-up transformers are connected to the generator at the power house. The second method is preferable to the first, in that it produces only one oscillation similar to the less severe of the two oscillations produced by the first method. The tests discussed in the paper were first described in a paper presented by the author before the American Institute of Electrical Engineers, as noted in our issue dated March 9, 1911.

The report was discussed by Messrs. Pizzuti, Campos, Dina and Kennelly.

TRANSIENTS IN ELECTRICAL ENGINEERING.

Dr. C. P. Steinmetz presented a paper in which were given complete mathematical analyses of transient phenomena in transmission circuits. He stated that an electrical transient is the phenomenon by which, when a change of circuit conditions is brought about, the stored magnetic and dielectric energies of the electric system readjust themselves to the changed circuit conditions. There are two general classes of transients, namely, single-energy transients and double-energy transients. Single-energy transients exist in those circuits in which energy is stored in only one form, usually as magnetic energy, and the transient can consist only of an increase or a decrease of the stored energy. Double-energy transients exist in those circuits in which energy is stored in two different forms, as magnetic and as dielectric energy, in which case, in addition to an increase or decrease of stored energy, there may be a transformation of the stored energy from one form to the other, the transformation usually being periodic.

In electric-lighting circuits of 110 volts, railway circuits of 600 volts, and even in primary distribution circuits of 2200 volts, the stored dielectric energy is so small as compared with the stored magnetic energy that it can be neglected, so that the circuit can be treated as storing energy in only one form. In overhead electric circuits of 30,000 volts and in underground cable circuits of 10,000 volts the dielectric energy is of the same magnitude as the magnetic energy, and such circuits cannot be treated as storing only one form of energy. An important relation in such circuits is the ratio between the self-induction and the capacity of the circuit. The square root of this ratio has the properties of an impedance, and may be called the natural impedance of the circuit. In overhead transmission lines this impedance is usually between 200 and 600 ohms. It is much smaller in underground cables and much larger in coil circuits, such as the high-potential windings of the transformer. One can calculate the voltage of an oscillation, surge, impulse or traveling wave from its current, or the current from the voltage, by means of the known value of the natural impedance of the circuit. Thus, if the natural impedance is 400 ohms and the maximum emf 120,000 volts, the maximum discharge current is 300 amp. A study of the value of the natural impedance is of great industrial importance in indicating the action which different circuit sections exert upon each other in either protecting or endangering each other.

Dr. Steinmetz showed that in circuits comprising sections of different character, such as transmission lines, transformers, load connection, etc., the energy surge is a combination of standard wave and traveling wave. At the transition point between successive circuit sections there is a transformation of voltage and current, with a transformation ratio which is the square root of the ratio of the natural impedance of the two circuit sections. When a traveling wave coming from one circuit section enters into a circuit section of higher natural impedance the voltage is increased, while when it enters a section of lower natural impedance the voltage decreases. The voltage transformation at a transition point means that the wave-crests of the voltage distribution in the one circuit section are higher than in the other circuit section. At the transition point a change of phase angle occurs, so that at this point both sections have exactly the same voltage, but the different sections have different potential distribution of the traveling wave.

PROTECTIVE CONDITIONS OF ELECTRICAL APPARATUS.

An outline of the theory relating to disturbances in electrical apparatus was given in a paper by Prof. E. E. F. Creighton. The author discussed the nature and source of electrical surges, the characteristics of insulation and construction, the characteristics of protective apparatus and certain practical and commercial adaptations. Attention was called to the fact that there can be no hard and fast rules to cover the subject of protection in general. However, a description was given of specific practices which are gradually crystallizing into definite form. It was stated that for potentials above 30,000 volts there is at present no available good arrester except that of the aluminum type. For transformers operated at emfs less than 30,000 the multi-gap arrester is cheapest and gives excellent results, although aluminum arresters give a higher degree of protection. For the protection of transformers on circuits of 2300 volts all of the conditions are favorable to the use of the multi-gap arrester. For the protection of generating-station apparatus the cost of protective apparatus is of relative insignificance, and the important requirement becomes reliability. For this service the aluminum arrester is the best.

First and foremost in the protection of transmission lines is the insulator, which should be selected with due regard to the relation between the potential to puncture and the potential to arc around the insulator. In lightning-infested localities transmission lines should be equipped with over-

head grounded wires. Bessemer-steel wire has been found unreliable for this purpose. Standard wires of open-hearth steel are best. Overhead wires should be grounded at every support. Two separate overhead wires are better than one, but to just what extent they are better no one is able to state. Metal guards around insulators are valuable on circuits carrying enormous power, but are usually not necessary under other conditions. The only protector to the service as well as to the insulator that is available to-day is the arcing ground suppressor, which involves a relay device by means of which the circuit is grounded for only sufficient time to suppress any arc that may have formed.

Public-Policy Topics Discussed at Credit Men's Banquet.

At the sixteenth annual dinner of the Electrical Credit Association of Chicago, held at the Chicago Athletic Club on Nov. 16, the list of toasts embraced two subjects of much present-day interest. Mr. William J. Hagenah, the public-utility expert formerly connected with the Wisconsin Railroad Commission, was first on the program of set speeches. His remarks on "Regulation of Public Utilities" showed a deep study of the subject. He pointed out that the regulation of railroads and the establishment of the Interstate Commerce Commission grew out of the grangers' movement of 1873. In the last few years there has been a similar wave of public scrutiny of the affairs of the public-utility corporations, and these utility problems are now perhaps to be regarded as acute.

Investigation shows that the idea that rates are generally excessive in order to pay dividends on watered stock is an exaggerated notion. The condition of affairs is due less to premeditation than to the frequent changes made necessary by the development of the art, supplemented perhaps by some carelessness in management. In studying the subject such matters as appraisals, scientific accounting, standards of service, rates and franchise provisions must be considered. Service is the first requisite of the public utility. After this come rates, and the speaker here analyzed the factors entering into the establishment of a reasonable rate. The difficulties of appraisal and inventory were set forth, and then the subject of intangible values was taken up.

Mr. Hagenah does not believe that any corporation can capitalize the value of franchises issued by the public; neither does he believe that natural monopolies can capitalize "good-will" value. But there is an intangible value of a public-utility property; there is a certain value above the simple physical value. This is called "going value." In explaining this the speaker pointed out that it is fair to make allowance in valuation for the losses in developing a business. On the other hand, it is equally fair to credit to that valuation the excess over a certain fair base rate of return in prosperous years. If 7 per cent be accepted as this rate return, it should apply from the first day of doing business and deficiencies or excesses should be charged or credited properly. That is the plan of the Wisconsin commissioners.

Courts of law and other authorities differ on the question as to what is a reasonable rate of return and figures varying from 6 to 8 per cent have been mentioned. The way to meet the great public-utility problem, to study it and to adjust it, is to constitute a body of experts provided by law for the purpose. These experts should be men of high character appointed for a long time, and should receive large salaries, with ample funds at their disposal to make the necessary investigations.

Mr. Harry A. Parkin, special assistant United States district attorney in Chicago, spoke on "The Sherman Act in Business." He took pains to say that his views were given personally and not officially. The main purport of the Sherman act, passed in 1890, is simple. It holds that every combination in restrain of trade is illegal, and its purpose is the fostering of free competition. Mr. Parkin recalled that one of the first applications of the Sherman act was when Debs was indicted in 1894 under that law for inciting a strike in restraint of trade. He sketched other cases and interpretations of the courts which have arisen since that time, paying particular attention to the Standard Oil and American Tobacco cases. The decisions in these cases were analyzed, and it was stated that the Supreme Court held that the mere size of a corporation, or the character of its business, or the ultimate end to which the corporation's activities tend, is not to be considered an element in contravention of the Sherman act. The point seems to be that if a corporation is organized with the intent to absorb other corporations, so that business is stifled, with the eventual result of increasing prices to consumers, this intent constitutes a violation of the Sherman act.

Mr. Parkin touched on the "rule of reason," stated by the Supreme Court to be necessary in interpreting the law. This "rule of reason" seems to be the use of common sense to ascertain if the purpose of the defendant or defendants is to establish a monopoly. "Calamity howlers" have hurt the business of this country far more than the Sherman act has. It is to be remembered that the Sherman act has not been changed since its enactment over twenty years ago, but as a matter of fact the manner of carrying on trade and commerce has changed. If the old method of doing business in this country and encouraging free competition is better than the "big-business" monopolistic idea, then the Sherman act as it stands does not need amendment. Mr. Parkin urged his hearers not to condemn the Sherman law without a thorough understanding of it, and above all not to be "calamity howlers."

Mr. A. O. Kuehmsted presided at the dinner and Mr. A. A. Gray was toastmaster. Mr. Julius Reynolds Kline gave an eloquent speech on "The Measure of a Man," and Mr. Harry A. Antram recited some Hoosier poems. Mr. F. P. Vose was master of ceremonies and Mr. Warren Ripple led the singing.

Financing Public-Service Corporations.

Mr. Andrew Cooke, vice-president of the Harris Trust & Savings Bank, addressed the Electric Club of Chicago on "Financing Public-Service Corporations" on Nov. 15. The speaker, among other things, said that capital should be reimbursed for the risks involved in any business, and he referred to the radical legislation in Iowa as hampering the public-service development in that State. In making valuations difficulty is often occasioned by theoretical appraisals; that is, appraising the value of a public-service property at its exact reproduction cost without taking into account the greater actual cost due to piecemeal construction as the property has grown.

Mr. Cooke made a plea for conservative financing, and remarked that the fixed indebtedness on the property ought not to exceed 80 per cent of its actual value. The stock should have a real value. This will remove or diminish the danger of foreclosure, because if the property is attacked the company can conserve its resources for a time by passing dividends. The speaker thinks that a return of 10 per cent on the stock is not too large, as in the present unsettled state of public opinion there should be some incentive to purchase the stock of the average public-service corporation.

One point emphasized by Mr. Cooke was that dividends should not be paid out of the property; that is, there should be ample allowance for depreciation. The speaker commented on the number of failures of small public-service corporations, and said that in small towns it is almost impossible to return the investment at the end of twenty-five years and at the same time make rates reasonable enough

to attract business. The mortgages of the bank with which Mr. Cooke is connected are drawn so that in making betterments only the difference between the cost of the old and the new apparatus is charged to capital account; the value of the old apparatus must be charged off to depreciation. A telephone company was mentioned where 33 per cent of the value of the property is allowed annually for maintenance, repairs and depreciation.

As a comparison it was shown that depreciation in public-utility plants is like the reserve fund in life insurance; it must be provided at all hazards. Another point usually insisted upon by the banks is that the company shall earn at least twice the bond interest charge, this charge being based on an indebtedness not exceeding 80 per cent of the value of the property. Financial houses discourage floating indebtedness. The liabilities of the company should be almost entirely in the bonds and stock. In case the property is attacked by demagogues coolness is needed perhaps more than courage. In time the pendulum will swing in the other direction, for in the end the rights both of the public and the investors must be preserved.

Municipal Regulation of Public Utilities.

Mr. Leslie C. Smith, superintendent of the water department of the city of Cleveland, read a paper at a recent convention of the League of American Municipalities, held at Atlanta, Ga., Oct. 6, on the subject of "Regulation of Public Utilities." In reference to the monopolistic character of public utilities, Mr. Smith said that the principle of competition had become so interwoven with benefits in commercial dealings that it had come to be understood as the only lever by which a commodity may be secured for a less price. No more fallacious claim can possibly be made in its application to any enterprise coming under the head of public utility. The question of finance is always one of vital import to a city, and that there can be economic results from the duplication of plants and the entering into open competition with intrenched capital is impossible. Wherever government authority may restrict the expenditure or the income of a corporation it faces immediately the alternative of lesser service. It seems to be an assured fact that whenever the speculative element is removed from the investor's outlay of money the desire on the part of the investor for improvement and development of his interests ceases.

In reference to the franchise ordinance under which the Cleveland Railway now operates, Mr. Smith said that it is evident that since the amount allowed by the city to the company for expenditures in operation is definitely fixed and the items to be included enumerated, any excess in such operating expenses must come from some other source. It is equally apparent that the first expenditure from the interest fund established will be the 6 per cent allowed the stockholders upon their investment. To maintain this latter amount intact it seems thoroughly axiomatic that the interest fund will not be depleted below an amount necessary to secure such dividends. The answer is then settled that if the return allowed for operating expenses be insufficient to guarantee necessary expenditures inferior service must of necessity arise.

In his conclusions on the subject of regulation Mr. Smith said that regulation or ownership can be made successful, but there must come some radical advancement in the laws which place the utilities at the mercy of varying administrations. Whether this be fixed in concession or actual interest return is of less importance than that it be just.

Mr. Smith also took up the question of the proposed municipal electric-lighting plant in Cleveland, and said that under the statutes there is no way of driving the existing company from its territory, and to compete with it the city must duplicate its distribution facilities. The experience of the past shows that it has taken the city five years to attain in one of its present small municipal plants the maximum usage of 1500 kw, and this is practically without competition. The establishment of a two-million-dollar plant under conditions even 100 per cent more favorable than those encountered heretofore would mean that much of the investment must lie idle for many years. The momentous question arises as to whether or not the gain to be achieved, if there be gain, will equal the loss to the people in interest, depreciation, obsolescence and other such elements as must of necessity exist and accrue if the large outlay is made before the development of the business justifies it.

Regulation of Public Utilities.

The twenty-third annual convention of the National Association of Railway Commissioners was held in Washington, D. C., on Oct. 10 to 13. While this association considers principally subjects relating to railways, it also takes up various questions affecting generally the regulation of public utilities.

Among the committee reports presented was one on railway capitalization. The chairman of this committee was Mr. Martin S. Decker, a member of the New York Public Service Commission, Second District. This report stated that in the issue of these securities the public is primarily concerned that they shall be sold for their full value and the proceeds applied to the construction or improvement of railway property. Secondarily, the general public has a strong interest in the proportion of stock to bonds and in the improvement of railway properties without unnecessary additions to the bond interest or a fixed charge account.

The report adds that in the absence of governmental regulations the interests of holders of stock and bonds and of the people as compulsory customers of the railways have not been protected in any reasonable degree. That such regulation is indispensable to the conservation of the true interest of the corporations, its shareholders and creditors, and the interests of the general public, is fast coming into general recognition.

Taking up the subject of regulation of the railways in New York State, the report says that the policy of the commission in regard to new companies authorized to build a railway is to make such allowance for preliminary work and organization as seems reasonable in each case. The commission allows full and even ample compensation for such services as may be shown. This fully recognizes valid claims, but prevents exploitation.

On the subject of additions and betterments the report says that after long operation the railroad company should be able to decrease rather than increase its mortgage debt, or at least be paying a substantial percentage of the costs of betterments and improvements from income without issuing bonds to cover such percentage of betterment or improvement cost. It should do this while accumulating at the same time a surplus available for use in times of sparse traffic.

The ever-swelling fixed charge, except as met by increased traffic returns, tends constantly to diminish net corporate income. The real test of the commercial value of a railroad property is found in its net earnings. It is encouraging, the report adds, to note that banking interests are not oblivious to the situation and that in the case of many smaller companies they have insisted that new mortgages shall contain a clause that future improvements and betterments shall not be made from mortgage bonds beyond a stated per cent of their cost. A similar safeguard might well be inserted in the mortgages of all companies.

The report of the committee was discussed at length by various delegates. Mr. O. P. Gothlin, Public Service Commission of Ohio, said that, notwithstanding that the law creating that commission had been in effect but three

months, many problems had been considered. Promoters had tried to ascertain the attitude of the commission as to what proportion of stock in a new property would be allowed for promotion services. Interurban railways and other utilities have come to the commission in cases where their existing indebtedness was so large that net earnings were not entirely sufficient to meet the interest requirements or the net earnings were barely sufficient and money was needed for extensions and improvements. The companies wanted in these cases to issue more bonds to "tide them over."

It appeared almost certain, Mr. Gothlin said, that this practice only meant the addition of further burdens and that the relief was only temporary. What was the commission to do in a case of that kind? Backers of new enterprises would appear before the commission to ask about the issue of stock and bonds for construction of the utility plant or railway.

Mr. Decker said it was a fact that many improvements did not begin to earn revenue until a number of years had passed, and some of them never earned revenue. It was not always easy to determine the exact compensation which was due the promoter—that is to say, the value of the service. The commission took testimony upon the subject, inquiring how long the promoter had been engaged in the work, what he had done and what expenses he had had. In that way a fair approximation of the value of services could be made. These were to be termed "preliminary expenses." The engineering services in preliminary surveys came under the same general designation. The cost of acquisition of rights-of-way would be included under the general term "preliminary expenses," but the commission did not lump all the expenses and say, "You are entitled to 50 per cent of this bond issue, or 50 per cent of the stock issue." It tried to determine a just compensation for the services rendered.

Continuing, Mr. Decker said that, while undoubtedly promoters who had been used to the practice of obtaining all or very large parts of the stock issue were disappointed by careful, reasonable state regulations, he did not think there was any wide discontent if the new policy was applied in a reasonable and considerate way. There was not in New York. There was discontent on the part of those who would like to have the old order continue, who would be willing, so long as they got their profits, to launch upon the public a corporation that was bankrupt from the start. In Mr. Decker's judgment, however, there are men engaged in the promotion of these enterprises who are of the highest character and who are acting with the view of getting legitimate returns from their efforts.

Mr. John E. Benton, New Hampshire, said that one of the difficult questions which confront the commission of that State was that of determining what increase in capitalization should be allowed to a utility which purchases a plant of a competing utility where the plant purchased is in large part a duplication of the other plant.

Mr. B. H. Meyer, Interstate Commerce Commission, stated that the Wisconsin statute provides that the securities of the consolidated company shall not exceed in the aggregate those of the constituent companies. The Wisconsin commission generally had taken the position that, even though the aggregate of the securities outstanding might exceed the value of a plant double the size in first-class condition, what the public required was good service. To give that service the company must have money and the commission must do whatever it reasonably could to put the company in a position where it could get money. It was one of the functions of the state commission to see that the money actually went into the property. Mr. C. A. Radcliffe, Public Service Commission of Ohio, said that promoters of new enterprises told the commission that it was impossible to sell stocks at any price. The only securities they could market were bonds.

Mr. H. Warner Hill, Georgia Railroad Commission, said that the primary purpose of conferring jurisdiction regarding stock and bond issues on state commissions was to prevent overcapitalization. This was a benefit to the corporation issuing the securities, because when such securities were issued with the approval of the commission it was understood that they had a definite value.

Mr. Meyer said that if a commission, as a regulating body, authorized the issue of $100,000 of stock and bonds by a public-service corporation all that the commission could say was that such amount had gone into the property. It was to be hoped that the property would be worth $100,000 to-morrow, but the commission could not say to anyone that it might be worth $200,000 or $150,000 or $90,000. No one could guarantee the investor a continuation of the values he believed he acquired. The public authority could see to it that what the investor bought represented substantially what had gone into the property. When that was seen perhaps all was done that could reasonably be done.

Mr. Franklin K. Lane, Interstate Commerce Commission, suggested the wisdom of going slowly in agitation of the control of capitalization and finding first if it was not possible to achieve every result desired by publicity and the exact and official ascertainment of the fact that the money raised went into the property.

The report of the committee on railroad taxes and plans for ascertaining the fair value of railroad property was written by Mr. Edward M. Bassett, formerly a member of the New York Public Service Commission, First District. This report stated that one rule for determining a fair rate of return that had considerable merit was to allow a rate that would be adequate at the present time to induce investment in a new enterprise of similar character. If it was decided that a public utility should be taxed on its total value as a going concern—that is to say, its commercial, market or sale value—then franchise and going value would be included. If, on the other hand, the utility plant was to be taxed precisely as other real estate, the cost of reproduction, less depreciation, would be the basis. There was no inherent inconsistency in using one method of valuation for tax purposes and another for rate purposes. The misplaced or partially obsolete plant or road is the one that causes greatest difficulty in valuations for any purpose. The books of the company, kept from the start in accordance with a correct accounting system, would show a capital account that would be closer to what seems a just, fair value for rate purposes than any other single basis.

Mr. Hill, of Georgia, presented the report of the committee on telephone and telegraph rates and service. This report considered the elements that should be taken into consideration in the determination of rates and referred to the activities of the various commissions which have jurisdiction over telephone and telegraph companies. So far as the committee is advised, only one commission, the Louisiana commission, has adopted tariffs and rules governing telephone companies.

The following officers were elected for the ensuing year: President, Mr. Charles F. Staples, Minnesota Railroad & Warehouse Commission; first vice-president, Mr. O. P. Gothlin, Public Service Commission of Ohio; second vice-president, Mr. H. Warner Hill, Georgia Railroad Commission; secretary, Mr. William H. Connolly, Interstate Commerce Commission; assistant secretary, Mr. William Kilpatrick, Illinois Railroad & Warehouse Commission.

Public Service Commission News.

NEW YORK COMMISSION.

The Public Service Commission, Second District, has prescribed a uniform system of accounts for telephone corporations in the State of New York. A public hearing was held

on Oct. 4, at which time representatives of the telephone companies had an opportunity to be heard upon this subject. The tentative scheme of accounts issued in July, upon which the hearing was held, has been modified in a few minor particulars, and as revised is now made the subject of an order by the commission to become effective on Jan. 1, 1912. Copies of the order will be served upon all telephone corporations subject to the commission's jurisdiction as soon as the pamphlet can be had from the State printers, in whose hands it now is.

The commission has served upon the Buffalo General Electric Company and the Cataract Power & Conduit Company the complaint of the Mayor of the city of Buffalo asking for an investigation regarding the prices charged the city of Buffalo for electricity used for the purposes of light, heat and motor service. The complaint alleges that the prices charged by the two companies are unjust and unreasonable and asks that the commission fix a maximum price to be charged. The companies have been required to answer the complaint within twenty days.

The Public Service Commission, Second District, has authorized the A. L. Swett Electric Light & Power Company to exercise franchises granted by the town of Somerset in the village of Barker, Niagara County, which provide for the erection and operation of an electric-lighting system in these localities.

The Public Service Commission, Second District, has authorized the Rochester Railway & Light Company to issue its consolidated 5 per cent gold mortgage bonds dated July 1, 1904, and due July 1, 1954, to the aggregate amount of $1,998,000. The bonds are to be issued in exchange par for par for Rochester Gas & Electric Company's 5 per cent twenty-year gold bonds issued under a mortgage dated Nov. 1, 1892, and due Nov. 1, 1912, as such last-mentioned bonds can be acquired by the Rochester Railway & Light Company.

The Public Service Commission, Second District, has authorized the Elmira Water, Light & Railroad Company to merge all the property, rights and franchises of the West Side Railroad Company of Elmira and transfer all franchises held by the West Side company to the Elmira company. The Elmira Water, Light & Railroad Company is the owner of all the capital stock of the West Side Railroad Company, and all the property of the West Side Railroad Company is leased to the Elmira Water, Light & Railroad Company for the term of its corporate existence.

MASSACHUSETTS COMMISSION.

The Board of Gas & Electric Light Commissioners has received a petition from the Mayor of the city of Malden contending that the price of electricity charged the city by the Malden Electric Company should be reviewed by the commission.

Decisions have been handed down by the board in the applications of the Buzzards Bay Electric Company and the Marion Gas Company for authority to extend their lines and carry on the business of selling and distributing electricity in the Bourne and Sandwich district of Cape Cod. Both companies desired to enter the town of Bourne in order to supply electricity to groups of summer residents. The board points out that the town covers a considerable territory and includes several distinct villages. The attitude of the municipal authorities was one of apparent indifference as to which company should supply electricity, so long as an adequate supply at reasonable prices was furnished. The board states that under all the circumstances both companies may well be restricted to those sections of the town which they respectively can most conveniently and economically reach. The Buzzards Bay company is therefore authorized to carry on its business in the towns of Barnstable and Sandwich, and in so much of the town of Bourne as lies within a specified area between Back River and the Plymouth boundary; and the Marion company is authorized to supply electricity in a specified adjoining area within the town.

The Seekonk Electric Company has petitioned the board for the right to issue new stock to the amount of $5,000, in order to purchase so much of the property of the Narragansett Electric Lighting Company, of Providence, R. I., as lies within the town of Swansea, Mass.

Among matters pending before the commission is a resolve requiring the board to report to the Legislature of 1912 upon the operation of demand meters, and to determine whether or not it is expedient to regulate or prohibit the use of such meters, the finding to be submitted by Jan. 15. At the final hearing recently Mr. E. W. Burdett, of Boston, appeared on behalf of the Massachusetts Electric Lighting Association and emphasized the increasing use of such indicators outside the system of the Boston Edison company. He stated that the Tenney companies, operating in Malden, Haverhill, Revere, Fitchburg, Salem and other cities, are beginning to take up the demand indicator as a possible improvement on former methods of estimating the characteristics of the consumer's load at particular periods. The contention was urged that parties opposed to the demand indicator should offer something better in its place, and that the commission should sanction the general principle of its commercial application. Mr. Burdett argued that the central-station interests of the State are anxious to have demand meters put under official supervision, so that all loose talk about bills being inaccurate can in some measure be stopped. The opposition claimed that demand indicators as at present used are unreliable, but introduced no testimony of an engineering character to prove the assertion. The public appears to fail to grasp the importance of ascertaining the demand as a means of determining the cost of serving specified classes of consumers. An attempt was made at the hearing to involve the question of differential rates, but the scope of the resolve confines the investigation to the use and regulation of demand meters rather than the adjudication of broad methods of charging for electrical energy.

NEW JERSEY COMMISSION.

A decision was rendered by the Board of Public Utility Commissioners of New Jersey on Nov. 14 in a case affecting the rates of fare of the Trenton & Mercer County Traction Corporation and involving consideration of the financial affairs of this company. The complainants in this case were located on lines of the company on which double fares are charged. The length of ride allowed for a single fare on these lines is shorter than the length of ride allowed on other lines of the same company. The commission held that differences in the length of ride afforded upon different lines of the same company for a single fare are not necessarily discriminatory. It also decided that one circumstance which may warrant a disparity in charge is greater density of traffic upon lines affording the longer ride for one fare. The corporation acquired by lease last year properties of other companies. In connection with the entire plan an issue of bonds was made to provide funds for rehabilitation. The board did not have at that time the powers which it now holds in respect to the issue of securities. The board, however, in the present proceeding decides that in case of doubt, based upon past experience in operation, as to whether earnings suffice to provide for operating costs and a fair return upon actual investment lower rates ought not as a rule to be imposed, unless their probable effect will be to stimulate a demand for service sufficient to offset the reduced price per unit. It was also held that the fact that the various lines of the system had shown a paper profit in past years was unfortunately no evidence that such profits were really earned. The board is disposed to think that if the property had been maintained in proper physical condition the dividends, or the greater part thereof, could never have been declared or paid.

OHIO COMMISSION.

It has been pointed out that the Ohio Public Service Commission has been greatly handicapped because of the amount of money necessary properly to organize and operate the office. The expense limit of $75,000 a year has been found inadequate, scarcely sufficient to give proper attention to an important case that may come up, should the corporation affected put impediments in the way. This amount is but little more than was required when the office had supervision of the railroads and interurban lines only. The members of the commission are the same as when the office was thus operated, and to make it effective it is believed by many that experts are needed for the heads of departments to take charge of other utilities, and investigators and examiners are needed for different purposes. Such men cannot be employed without funds. Valuations are to be made in the case of proposed consolidations and in changing or fixing rates, except in the case of street railways alone, and how this work is to be done is a question that is facing the commission. To make matters worse, many trivial questions are brought before the commission which require much time and cannot be overlooked. Without the proper organization, the members of the commission must look after these matters themselves. Whether true or not, it is said by some that the opposition was so powerful against the bill which created the commission that the funds for its support had to be thus limited in order to secure its passage in the Legislature, and it is even hinted that this was a plan to secure its failure in practical operation. It is believed that the next Legislature will be compelled to change the limit of expenditures and allow a sufficient amount of money to make the office a success.

CURRENT NEWS AND NOTES.

American Institute of Consulting Engineers.—An informal dinner meeting of the American Institute of Consulting Engineers will be held at the Aldine Club, New York, on Dec. 1.

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Doll with Electric-Light Trimmings.—At a forthcoming charity bazaar in Chicago an attraction in one of the booths will be a handsomely dressed doll brilliant in a necklace of electric lights. A battery concealed in the flowing drapery supplies electricity to a number of 6-volt miniature lamps, and by means of an unobtrusive switch the current may be turned on or off.

* * *

Electric Lighting in the Desert.—It is suggested that where long electric transmission lines cross desert regions, as in some parts of California, for instance, arrangements may be made to provide electric beacons or lamps at dangerous road crossings where travelers are apt to get off the beaten line of travel at night. The proposal is in line with the suggestion that signboards be placed at intervals along routes of travel in a desert country for the benefit of travelers.

* * *

Regulated Art in Pittsburgh.—The Mayor of Pittsburgh has appointed an art commission for the purpose of securing uniformity of design in all public buildings and other structures with a view to beautifying the city. The commission is vested with large powers, though it cannot enforce its recommendations. The members serve without compensation. All designs for bridges, lighting and structures to be erected by public-service corporations must be approved by the commission.

* * *

Electric Cooking at Illinois Penitentiary.—Experiments being begun with electric cooking for the wardens' mess kitchen of the Illinois State Penitentiary at Joliet may be followed by such cooking on a larger scale for the inmates. The State purchases its energy from the Sanitary District of Chicago, whose hydroelectric plant is only a short distance away from the prison, obtaining this electricity at the low rate of 1 cent per kw-hour. The work in the penitentiary kitchens is all done with convict help, and specially heavy electric cooking appliances are to be used to withstand the careless handling by the inmates.

* * *

Philadelphia Section of I. E. S.—At a meeting of the Philadelphia Section of the Illuminating Engineering Society held Nov. 17 two papers were presented for discussion. The first speaker of the evening was Mr. E. J. Brady, who read a paper on "A Comment on the Application of Photometric Data to Interior Illumination." This paper, while short, proved very interesting. The second paper was read by Mr. George S. Barrows, on "Natural Gas: Its Productions and Utilizations." This paper, which was profusely illustrated with lantern slides, proved of great interest to those present. The papers were discussed by Messrs. C. O. Bond, I. N. Knapp, George B. Muth, Professor Rowland and others. The meeting was attended by 122 members and 66 guests.

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Public Utility Regulation in New York City.—A pamphlet on the subject of "State Regulation of Public Service Corporations in the City of New York" has been issued by the commission for the First District. The pamphlet was written by Mr. James Blaine Walker, assistant secretary of the commission, and was distributed to the public at the recent budget exhibit in New York City. It contains a summary of the changes and improvements made in the service and property of the various public service corporations in New York City since the creation of the Public Service Commission in 1907. It also gives an abstract of the public service commissions law, and describes the regulation and rapid-transit work of the commission. One chapter is devoted to gas and electric companies. It shows that from Aug. 1, 1907, to June 30, 1911, 2217 electric meters were tested. In the period from July 1, 1907, to June 30, 1911, 1,378,625 gas meters were tested.

* * *

Electrical Code in Pittsburgh.—The Electrical Boosters' Club, of Pittsburgh, is taking an active part in the struggle now being waged in that city over the adoption of the National Electrical Code by the city Bureau of Electricity. The Board of Fire Underwriters has preferred charges against the bureau concerning the firm-alarm system, claiming that the rules for electrical wiring are antiquated and the fire-alarm system inadequate and defective. At a hearing before the councilmanic committee on public safety an agreement was reached that the bureau would accept the national code with certain modifications, although the Underwriters insisted that the code be adopted in its entirety. Some of the councilmen insisted that if the national code were adopted it should mean a reduction in insurance rates. While the representatives of the Underwriters would not agree to this, they admitted that the present regulations were one element that made the basis of the high rates charged in Pittsburgh.

* * *

Block Lighting Plant.—In Chicago, as in other cities, there are a number of "block" electric-lighting plants that sell electricity within the confines of a city block, or in some cases to buildings outside the block where the plant is located. Such an installation is the Herman Koenig Furniture Company, to which the City Council of Chicago has granted a twenty-year ordinance permitting it to place wires in, along and above the east-and-west alley in the block bounded by West Chicago Avenue, North Green

Street, West Superior Street and North Sangamon Street for the purpose of supplying electricity in that portion of the block lying between West Chicago Avenue and the alley mentioned. The company, like other central stations, must pay the city 3 per cent of its gross receipts as compensation.

* * *

PRACTICAL APPLICATIONS OF THE GYROSCOPE.—Prof. G. M. Wilcox, of Armour Institute, Chicago, lectured on "Practical Applications of the Gyroscope" on Nov. 21 before a joint meeting of the Armour Branch of the American Institute of Electrical Engineers and the mechanical and civil-engineering student societies.

* * *

ELECTRICITY IN ORCHARD WORK.—To protect orange orchards from injury by frost a dense smoke is produced from smudge pots. In the case of a sudden decline of temperature it was sometimes found impossible to light all of the pots in a large orchard before damage was done. To obviate this risk a means has been devised whereby all pots may be lighted almost simultaneously, consisting of a priming fuse immersed in fuel oil in the smudge pots.

* * *

INVENTORS' PERIODICAL.—On Nov. 1 the publication was commenced of a monthly journal called *The Inventors' Outlook*, having for a purpose to represent the interests of inventors, including the advocacy of laws to protect their rights. The publication is issued monthly at a subscription price of $1 per year. The address is *Inventors' Outlook*, Provident Savings Bank Building, Washington, D. C. This item as previously printed was rendered unintelligible by a printer's error.

* * *

ELECTROLYSIS REPORT IN CHICAGO.—Mr. L. E. McGann, commissioner of public works of Chicago, transmitted to the City Council on Nov. 20 the report of Mr. Ray Palmer, consulting engineer, who had been retained by the city to make an investigation and report on the damage to water pipes and other metallic structures due to electrolysis set up by escaping electricity, mainly from street-railway returns. The report was ordered published and referred to the water department committee.

* * *

ELECTRIC-LIGHTED RAILROAD CARS IN THE UNITED STATES.—Of the 50,000 passenger cars in use on the steam railroads of the United States, 11,017 are electrically lighted, according to the report of the committee on data of the Railway Electrical Engineers' Association. The fifty-eight roads, including the Pullman company, which operate these cars have 33,634 other cars not electrically lighted. The systems used number as follows: Straight storage, 1372 cars; head-end, 192 turbine-generator cars and 3185 cars lighted; axle-generator cars, 5900. The Pullman company operates 2400 electrically lighted cars out of its 4264 cars in service, using the axle-generator system exclusively.

* * *

MEXICO A. I. E. E. MEETING.—The Mexico Section of the American Institute of Electrical Engineers held a successful meeting on Nov. 10. About thirty members and guests gathered at supper in the Triangle Inn in the city of Mexico at 8 o'clock, and at the conclusion of the repast the meeting was held in one of the Y. M. C. A. meeting-rooms. A paper was presented by Mr. W. B. Hale on the recently completed installation of an underground telegraph cable in the city of Puebla, which is the longest and most important telegraph cable of its kind in Mexico. Mr. P. M. Bennett gave an interesting description of the laying of electric-service and telephone cables in the same city. Considerable discussion followed the reading of these papers, after which election of officers took place. Mr. W. H. Fiske, chief engineer of the Mexico Tramways Company and Mexican Light & Power Company, was elected chairman, and Mr. H. S. Foley, superintendent of distribution of the same companies, was elected secretary for the coming year. The chairman is to appoint an executive committee of three members, whose names will be announced at the next meeting of the section.

* * *

PERCENTAGE OF LOSSES TO SALES IN ELECTRICAL MERCHANDISING.—In comparing notes at a recent conference of credit men of electrical houses one of the gentlemen present, representing one of the large concerns of the country, which sells nearly all kinds of electrical goods to customers of all sorts, said that during the last fiscal year the company's losses in bad debts were 0.42 of 1 per cent of total sales. More interesting still was his classification of losses by different groups of customers. The ratios of losses to sales are given in the following list: Railways, both steam and electric, 0.04 per cent; central stations, 0.09 per cent; telephone companies (Independent), 0.16 per cent; miscellaneous, 0.38 per cent; isolated plants, 0.51 per cent; contractors, dealers and jobbers (principally contractors), 1.24 per cent.

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SCHENECTADY A. I. E. E. SECTION MEETING.—The Schenectady Section of the American Institute of Electrical Engineers recently opened the 1911-12 season by an informal smoker which was held at the Mohawk Golf Club, of Schenectady. After an overture by the section's orchestra, Mr. E. B. Merriam, chairman of the local section, made a short address and then introduced in turn Mr. Ralph W. Pope, honorary secretary of the A. I. E. E.; Mr. W. B. Potter, engineer of railway and traction department General Electric Company, and Dr. Charles P. Steinmetz, who responded and outlined the advantages of membership in the Institute. Following the address, the Jest and Song Club, of Schenectady, gave a minstrel show abounding in witicisms and humorous references to well-known engineers who were present. At the conclusion of the entertainment refreshments were served, during which the Union College Glee Club rendered selections, and then the members of the section and their guests joined in singing the choruses of popular songs, the words of which were by the means of a stereopticon thrown on a screen. The smoker, which was successful in every way, was attended by approximately 400 people.

* * *

AUTOMATIC TELEPHONE SERVICE IN CHICAGO.—Thirty thousand automatic telephones are now in use in Chicago, according to the receivers of the Illinois Tunnel Company, who are operating this new system. Additional automatic telephones are being installed in Chicago at the rate of 75 to 100 a day, it is said. Toll-line connection has now been obtained with points in Illinois as far as Springfield, and it is expected shortly to complete the gap between that city and St. Louis, which will open up the large Independent field of Missouri and adjoining states for Chicago connection. Another line is being built to connect Chicago with South Bend, Ind., which will give Chicago connections to all Indiana and Michigan points. To points reached by its toll lines the automatic company offers five-minute connection at the same rate heretofore charged for three minutes' conversation, while a discount of 40 per cent is allowed off the regular day rate for long-distance calls between 6 p. m. and 7 a. m. An interesting feature of the automatic telephone service in Chicago has been the large number of Chinese subscribers obtained. The Chinese have trouble in calling numbers over the manually operated switchboards, it is declared. Chinese subscribers of the Illinois Tunnel Company are provided with special calling dials having both the ordinary figures and their Chinese equivalents. A Chinese directory has been printed especially for the benefit of these subscribers, who can thus reach their own countrymen directly, as well as any other automatic telephone in the city.

Wireless Interconnection of Colleges.—A movement has been started toward connecting the more important universities and colleges of the country by wireless telegraph. When the distance between colleges is too great for direct communication a message would be relayed from one or more intermediate college stations.

* * *

Forced Ventilation of Car Motors.—While forced ventilation has been applied to the motors of a number of large electric locomotives, its first use on motor-car equipment on a large scale has been tried out during the past year on the suburban service of the Pennsylvania and Long Island railroads. A pair of small motor-driven blowers is mounted beneath the truck bolster so that one blower furnishes air to each of the nominal 220-hp car motors, permitting their continuous operation at a rating much higher than would be otherwise possible. The air for this purpose is taken from well up the side of the car to avoid drawing dust into the motors.

* * *

Comparison of Street-Lighting Systems at Worcester, Mass.—In connection with a movement to secure additional illumination on the business streets of Worcester, Mass., a trial installation of thirteen 6-amp magnetite arc lamps has been placed in service in the Mechanics' Hall district, in addition to the ordinary system of 4-amp magnetite lamps used in the city for general street lighting. The lamps are installed on short temporary standards for comparison with a plan of tungsten cluster lighting proposed by the local merchants' association. At a recent view by the lighting committee of the City Council a preference was expressed for the use of low-hung arcs on inverted goosenecks instead of tungstens.

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Producer-Gas Investigations.—The Department of the Interior, Bureau of Mines, has published in convenient form a résumé of producer-gas investigations extending from Oct. 1, 1904, to June 30, 1910. The tests were made by the United States Geological Survey at St. Louis, Mo., and Norfolk, Va., and later at Pittsburgh, Pa., and the investigations are now being continued by the Bureau of Mines, to which this branch of the work of the Geological Survey has been transferred by act of Congress. Besides the tests on the pressure-producer installations at St. Louis and Norfolk and the down-draft producer at Pittsburgh. there is an excellent bibliography on the subject, covering some twenty pages.

* * *

Institute of Operating Engineers.—Colonel Goethals Branch (Yazoo City, Miss.) of the Institute of Operating Engineers started its regular bi-monthly meetings the last part of September. In this branch it has been decided to conduct a full course in which papers will be presented covering the subject "The Boiler-Room and Its Special Attachments" and all the problems connected therewith that an operating engineer should know. At each meeting the members are given a subject for discussion at the next meeting. The New York branch held a meeting on Oct. 20 and voted to name the branch after Mr. J. C. Jurgensen, the founder of the Institute. In this branch it has been decided to give a course of lectures during the winter on power-plant accounting. A new educational bulletin will be ready for distribution Nov. 20, which will give the announcement of special rates secured from the correspondence schools for students who wish to take up the I. O. E. work by the correspondence method.

* * *

Street-Lighting Extension in Chicago.—The Sanitary District of Chicago is under contract to install and operate 10,000 additional arc lamps for street lighting in the city of Chicago. But some of the aldermen think that this is not enough, and the finance committee of the City Council is considering propositions that this number be doubled or even increased to 30,000. The number of street arc lamps now in regular service is about 12,200. The 10,000 new lamps, or a large proportion of them, will be 10-amp flaming arcs, and about 100 lamps of this type are now under service test in the central business district, being in many cases attached to the elevated-railway structure of the Union Loop. The lamps being tested were furnished by the Stave Electrical Company and the General Electric Company. The contract for the initial order of 4000 flaming-arc lamps depends on the result to be shown by this service test.

* * *

Hawthorne Men's Club.—Employees at the Hawthorne Works (Chicago) of the Western Electric Company have organized a club to be known as the Hawthorne Men's Club. Membership is open to all employees at Hawthorne, and about 1500 have been enrolled. The club has been organized for the purpose of bringing the employees of the various departments into closer association with one another and to promote good fellowship. It is planned to have suitable entertainments, lectures on various subjects, especially those relating to industrial work, and to stimulate the entertainment and athletic activities of the employees. The second floor of the new restaurant building, recently completed, will be used as the club headquarters. At the preliminary meeting held to launch the club and to formulate a method of procedure for effecting a permanent organization Mr. H. F. Albright, general superintendent of the company, addressed the members. In accordance with the plan adopted at this meeting nominees for the various offices were named at a primary election, and at the election held a week later the following candidates were elected: President, Mr. T. R. George; vice-president, Mr. W. F. Hosford; secretary, Mr. G. B. Hallett; treasurer, Mr. W. L. Jonathan. A committee on constitution and by-laws will be appointed, and a meeting of the club will be held soon to act on the committee's recommendations.

* * *

Motor-Operated Stoney Spillway Gates for the Gatun Dam, Panama.—The water levels behind the Gatun and Miraflores dams at Panama will be maintained at constant heights by twenty-two motor-operated Stoney gates mounted in the concrete spillway sections. The Gatun spillway has a total length of 808 ft. on the arc of a circle 280 ft. across, and discharges into the old bed of the Chagres River, against whose flood periods it is designed to protect the dam structure. Each steel gate, 46 ft. wide, 19 ft. high, and weighing 43 tons, is to be suspended between concrete piers 115 ft. high, above sea-level, and will seat on the spillway crest. Extending through the center of the dam structure is the tunnel containing the gate-operating mechanism. The motor shaft for each gate operates the worm-nuts engaging the bronze screws by which the gates are moved. These screws with their swivel chains are counterweighted so that the motors are relieved of any lifting effort and have only to overcome friction. Each gate can be lifted through its entire travel in ten minutes, and at the ends of its path is equipped with limit switches which shut off the motor in the direction of its travel. The motor can, of course, be reversed at any point of its travel. Seepage water collecting in sump pits within the dam will be removed by three portable pumping sets, each comprising a vertical centrifugal pump direct-conected and built into an inclosed waterproof induction motor, the complete outfit being designed to operate beneath 30 ft. of water if necessary. These pumps will deliver 45 gal. a minute against 32 ft. head.

HILLSIDE STEAM-TURBINE STATION AT CRAWFORDSVILLE, IND.

Twenty-Year-Old Reciprocating-Engine-Driven Equipment Replaced by Modern Turbo-Alternators.

Coal Discharged Into Sloping Concrete Bunkers from Dump-Bottom Cars on Railroad Track 85 Ft. Above Level of Creek from Which Water Supply Is Taken—Tunnel for Removing Ashes.

COAL delivery from a railroad track on the top of an 85-ft. bank, condensing and boiler-water supply from a stream at the base of the bluff, and the foundations for a turbine power plant on the side of this alluvial slope, were among the conditions imposed in the design of the new station of the Crawfordsville Electric Light & Power Company, just completed at Crawfordsville, Ind. In the arrangement of its hillside coal bunkers, water-circulating system and general equipment, as well as in the low unit costs of the stations, the Crawfordsville plant is therefore of rather unusual interest among similar small stations of its class.

The building, which sits on a level shelf 21 ft. above Sugar Creek and 64 ft. below the top of the alluvial bluff, is of concrete, brick and steel, measuring over all 71 ft. x 75 ft. in plan. The boiler-room occupies a floor space 71 ft. x 40 ft., and the engine-room 54 ft. x 34 ft. At the north end of the latter a 14-ft. space extending across the room is divided by a 7-ft. hall into the plant office and the lavatories. Overhead on the small second story thus formed is space for a laboratory for carrying out plant tests. Behind the boiler-room and extending up the slope are the concrete coal bunkers 64 ft. wide, and 90 ft. in length measured along the 40-deg. slope.

HILLSIDE COAL BUNKERS.

Dump-bottom coal cars from a spur of the Monon railroad track are run out over the trestle in Fig. 2, which is carried by four steel piers above the bunker, and discharge their contents onto the sloping floor beneath. The steel track piers are seated on heavy concrete footings carried into the side of the hill, and in the central panel provision is made for a future motor-driven coal crusher. The floor of the bunker is a continuous 8-in. concrete slab carried on stepped pedestals seated on horizontal bearing surfaces of the sandy material of the bluff. The lowest 17-ft. section of the bunkers is especially reinforced for the storage of coal and will hold 500 tons in the pile as the coal lies. The bulkhead wall separating the bunkers from the boiler-room is reinforced by internal concrete buttresses erected in the bunkers, which buttresses also serve to separate and direct the coal into the chutes leading to the stokers. The concrete bunkers are to be roofed to prevent wetting of the coal by weather, and are drained of rainwater by vitrified-tile conduits leading from their lowest sections.

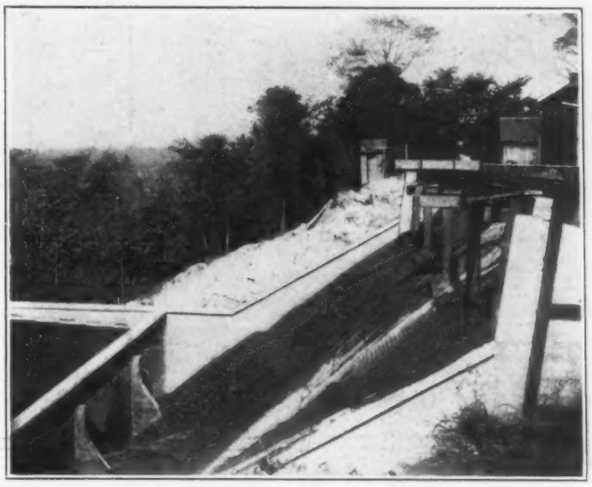


Fig. 2—Hillside Coal Bunkers, Showing Trestle and Roof of Boiler-Room.

From the bunkers coal enters the boiler-room by gravity through 12-in. circular openings, one for each boiler. Each opening is provided with a cut-off valve operated by a pull-rod from the floor. It is also planned to equip each of these thimbles with a propeller-type coal meter for measuring the quantity of fuel burned in the plant. The chutes connecting the entry thimbles with the hoppers of the Roney automatic stokers are now temporarily constructed of wood, as shown in the accompanying illustration. After the best form of these chutes has been found by experiment permanent steel inclines will be erected.

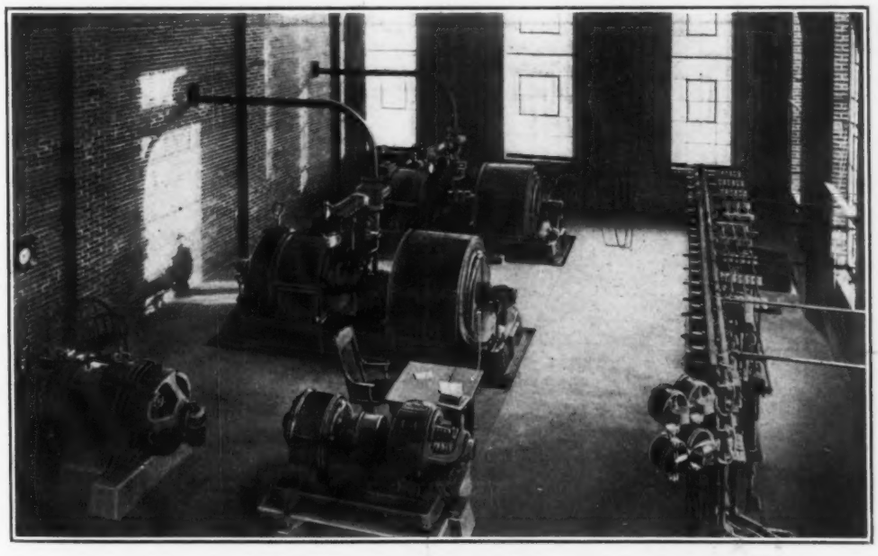


Fig. 1—General View of Turbine-Room.

BOILER-ROOM EQUIPMENT.

Three of the four 350-hp Stirling water-tube boilers are now installed, being fired by automatic Roney stokers, as already mentioned. The flue gases from the furnaces are led through a breeching at the rear of the 150 ft. Kellogg stack, 7 ft. in interior diameter, at the south of the plant.

The provision for the handling of ashes at the Crawfordsville station is rather unique, consisting of a concrete tunnel 4 ft. wide and 6 ft. high, through which run hand-operated ash cars on an industrial-gage track. The ashes are dumped directly into the cars through 18-in. chutes and swing doors leading from the bottoms of the ash pits of each boiler. There is also a 12-in. vertical opening from the combustion chamber to the center of the tunnel ceiling, which can be used for cleaning out dust and material that

collects in this space. As the ash cars are filled they are run out by hand and the ashes used to fill waste bottom lands near the plant. The Hoppes feed-water heater and hot-water tank are mounted on a steel structure above the boiler-feed pumps between the middle boiler settings. The

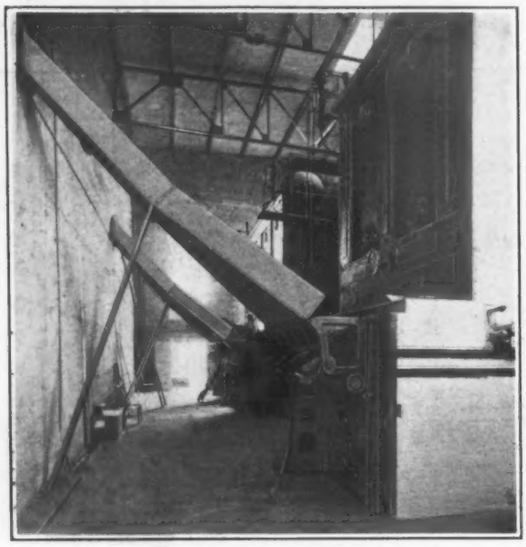


Fig. 3—Boiler-Room, Showing Chutes from Hillside Bunker.

feed-water heater receives the condensation from the turbine-driven exciter, stoker engine and boiler-feed and service pumps.

Steam produced by the boilers, at 175 lb. pressure per square inch, is delivered through 7-in. lines to the main 10-in. header, paralleling the partition wall inside of the boiler-room. From this header the two 4½-in. steam lines leading to the turbines are taken off, the Cochrane steam separators with which each is equipped being mounted in the boiler-room directly beneath the main header, whose condensation they also serve to catch. Through extension hand-wheels all steam valves as well as exhaust valves in the plant are operable from the main-floor level.

TURBINE GENERATORS.

The present two units installed in the station are 625-kva Curtis-General Electric horizontal turbo-alternators, delivering 2300-volt, 60-cycle, three-phase energy. Provision is made at the north end of the turbine-room for a future 1250-kw unit of similar type. All bearings of the present units are water-cooled. The turbines exhaust through 24-in. lines, fitted with expansion joints, into the Alberger jet-type condensers located in pits in the basement beneath the turbine-room. These condensers are designed to give a vacuum of 28 in. with cooling water at 70 deg. Fahr.

Injection water for the condensers is taken from Sugar Creek, which flows in front of the plant, through a 4-ft. 6-in. concrete intake tunnel. The water is now freed of entrained and floating material by temporary screens, but later a permanent screen house is to be erected near the water's edge. Both the intake and discharge tunnels can be reached through a concrete-lined well outside the plant, and both tunnels are large enough to admit a man to enter for inspection or repair. The water circulation to the condensers is handled through 10-in. pipes, both intake and discharge, and the condenser vacuum pumps are driven by 35-hp, 2300-volt, three-phase induction motors. A 3-ft. dam in the condenser discharge tunnel forms a hot-well 15 ft. in length and 5 ft. 8 in. wide, the tunnel being widened at this point, and from this hot-well the steam-driven service pumps take their supply, which is delivered to the feed-water heater and the hot-water tank already mentioned. These pumps are also provided with an auxiliary suction line from the intake tunnel, which can be used in case the hot-well is emptied for any reason. The steam pumps, which are mounted in the pits, are also arranged with a sump intake for clearing their own space in case of flood or back water from any cause. At a point just below the power house a low dam has been erected, forming a pond in the creek, 100 ft. wide and 3 ft. deep, extending a distance of ¼ mile upstream, and insuring an ample source of condensing water for the plant, even under conditions of diminished flow in the stream. The outlet tunnel emerges 100 ft. distant and downstream from the inlet passage, so that in case of low water in the creek the contents of the pond can be circulated as a cooling basin. The discharge tunnel, which is the higher of the two conduits, has its center line 8 in. below the water level.

AUXILIARY ELECTRICAL EQUIPMENT.

Excitation for the turbo-alternators is furnished by one 25-kw Curtis turbine-driven direct-current generator run-

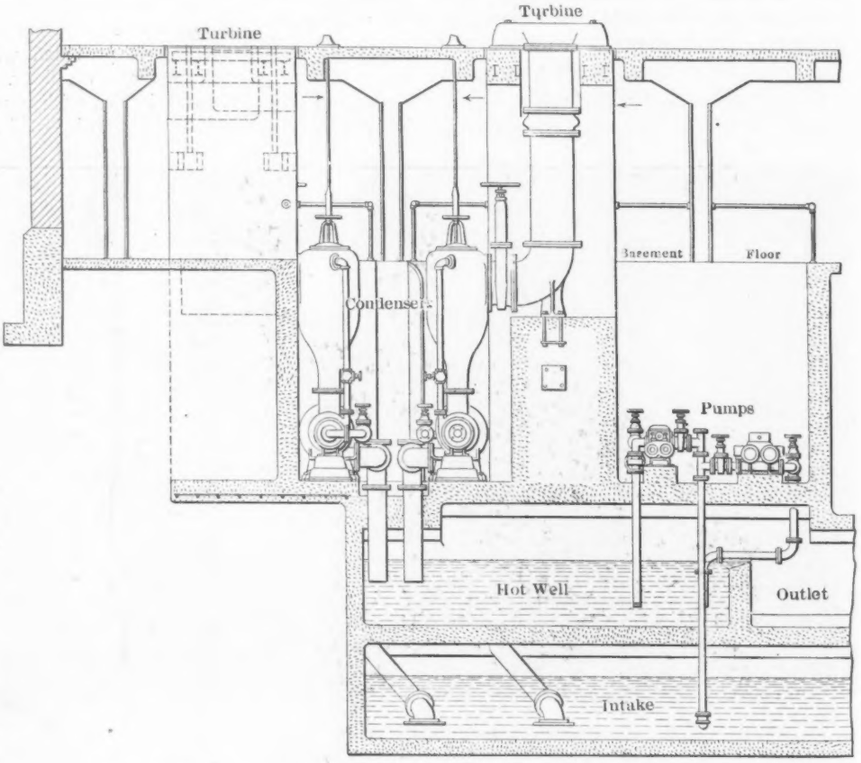


Fig. 4—Section Through Condenser Pit, Water Tunnels and Pumps.

ning at 3600 r.p.m. and one 25-kw induction-motor-generator set, both mounted on the floor of the turbine-room. These exciters like the main turbine units were furnished and installed by the Fort Wayne Electric Works. Control of the station is centralized in a black slate switchboard

22 ft. long, paralleling the west wall of the turbine-room and containing the following sections: One regulator panel equipped with Tirrill induction regulator, two exciter panels, two generator panels, two feeder panels, one arc-feeder panel and five rectifier panels, four of which are

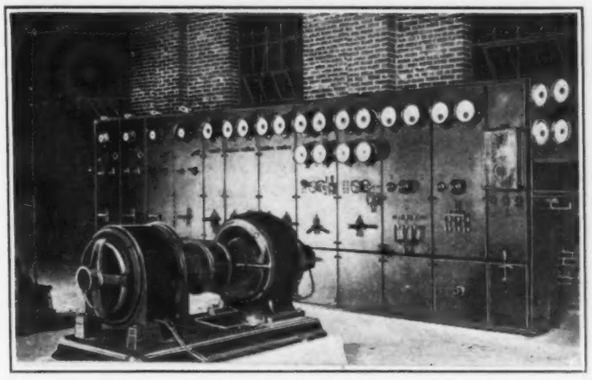


Fig. 5—Switchboard and Motor-Driven Exciter.

already equipped for controlling the four fifty-lamp Westinghouse 4-amp metallic-flame rectifier sets in the basement. Besides the usual complement of wattmeters, ammeters, voltmeters, etc., there are provided a synchroscope, a frequency-meter and watt-hour meters for registering the consumption of the arc and commercial circuits, all the instruments, like the switchboard, being of Westinghouse manufacture. The arc-rectifier panels and main oil switches are all provided with alarms which cause the continued ringing of a bell in case there is automatic opening of any circuit.

On the boiler-room division wall of the turbine-room is mounted a recording steam-pressure gage and a manometer for registering the draft of the stack. The entire turbine-room floor can be reached by the hook of the hand-operated 10-ton Whiting crane.

Installed in the basement, directly below the switchboard, are the four fifty-lamp 4-amp Westinghouse metallic-flame rectifier sets, alongside the chain-operated generator field rheostats which are also installed in the basement. These rectifier sets are controlled entirely from the switchboard above, even the starting of the tubes being manipulated by tilting chains from handles in the overhead panels.

DISTRIBUTION TO CUSTOMERS.

From the power house on overhead pole lines there radiate, besides the arc circuits, four 2300-volt, three-phase feeders, one of which is reserved for service to motor customers and the other three for lighting. An accompanying illustration shows one of the pole lines leaving the station, which carries both arc and commercial feeder circuits. This line is built over a particularly rough creek-bottom profile, and the photograph reveals the excellent alignment of the construction in spite of the fact that the irregularity of the country necessitates the use of poles from 40 ft. to 20 ft. in length.

The new station was started up July 23, 1911, the local service being converted at the same time from single-phase, 1100-volt, 133-cycle, to three-phase, 2300-volt, 60-cycle operation. This change was accomplished in six days, both plants being kept in operation during that time so that no customers were without service for more than an hour's time during daylight. The old plant replaced by the station above described contained 250 kw in reciprocating engine-driven equipments and three fifty-light open-arc machines, and had been in operation continuously almost twenty years since Aug. 21, 1891.

There are 1150 consumers of electricity in Crawfordsville, which has a population of 9700. Nearly 900 kw in transformer capacity is installed, and there is a connected load of 193 hp in motors. The major portion of the customers' services—1053, to be exact—have meters.

The cost of the completed new station with its present equipment was $111,929, of which $2,500 is due to real estate. When the plant was started it was intended to install only two 350-hp boilers and one 300-kw and one 500-kw turbine, the cost of the station with this equipment being estimated at $93,000. Enlarging this estimate by the same proportion as the increase in rating finally installed brings the estimated cost of the station within $600 of the amount actually expended in its construction. These figures are especially noteworthy on account of the peculiar requirements imposed by local conditions and the large quantity of concrete used in the construction of the station, foundations, tunnels and coal bunkers. Excluding the 200-lamp metallic-flame arc equipment, which is of the nature of substation apparatus, and completing the equipment of the station to its designed capacity with two 650-kva and one 1250-kva turbine, the total unit cost of the plant will be well under that usual for such stations.

The Crawfordsville Electric Light & Power Company, which is the name under which the local business is carried on, is a municipal corporation owned by the citizens of Crawfordsville and administered since 1903 on business principles by a board of three trustees, one of whom is elected yearly for a three-year term. Mr. M. W. Bruner is president of the board, Mr. G. B. Luckett secretary, and Mr. G. F. Huggans treasurer. Mr. J. R. Thomas, the present manager and superintendent of the plant, who is a technical graduate of progressive ideas, has served in

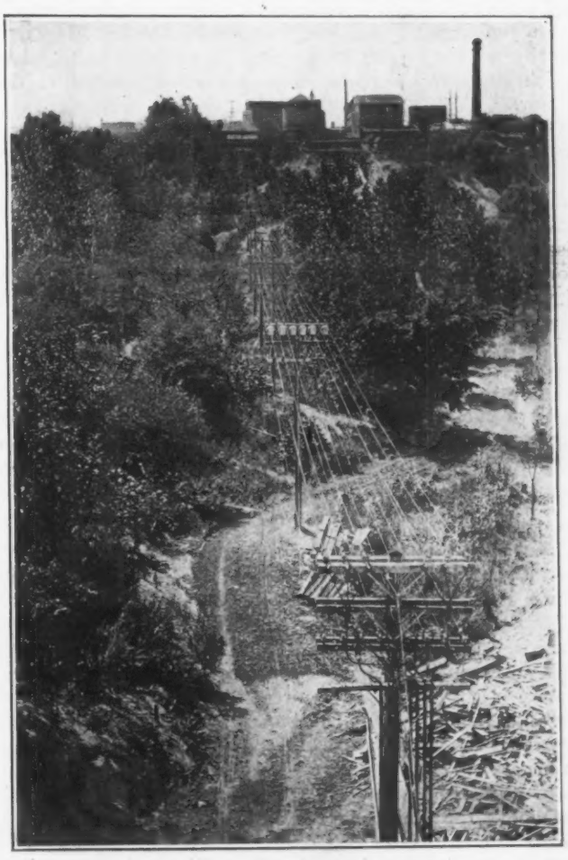


Fig. 6—Main Feeder Line.

this capacity since July 13, 1903, several months in advance of the taking over of the station by the trustees. Mr. Elby Shelly is chief engineer of the power station. The plant was designed and its construction supervised by the Esterline Company, Lafayette, Ind.

THE GENERATING AND TRANSMISSION SYSTEM OF THE TELLURIDE POWER COMPANY—II.

Six Generating Stations in Utah and Idaho Furnishing Energy to All Electric-Railway Systems in Utah, to Local Central-Station Organizations, Mining Camps, Pumping and Irrigation Projects, Etc.

IN a previous article the early history of the Telluride Power Company, from the first experiments with a 3000-volt transmission in 1890 until the present time, was told. An outline of the Colorado system and descriptions of its various generating stations and transmission lines were also given in the same issue. In the present article there is given the first part of a description of the Utah system of the company.

WATER RESOURCES, UTAH DEPARTMENT.

The water supply of the Telluride Power Company in Idaho and Utah is derived from the Wasatch Mountain drainage area of the so-called Great Basin of the continent lying at the west of the Rocky Mountains. Topographically this interior drainage area is characterized by isolated, narrow mountain ranges, trending north and south and separated by broad valleys varying considerably in altitude, the general elevation of the northern area being from 4000 ft. to 5000 ft. with mountains sometimes attaining elevations of from 10,000 ft. to 13,000 ft. The chief rivers of the Great Basin rise in the mountains which form the eastern and western borders, and the water supply is derived largely from melting snow. The maximum stream discharge usually occurs in the late spring or early summer, after which the flow decreases to a minimum reached in the winter.

The Wasatch Mountains drainage area includes the western half of Utah and small portions of Idaho and Wyoming, the streams heading either in the mountains or plateaus to the south and discharging into Great Salt Lake or Sevier Lake. The principal rivers are Bear, Logan and Weber, discharging into Great Salt Lake, and Provo, American Fork, Hobble Creek and Spanish Fork, discharging through Utah Lake and the Jordan River into Great Salt Lake, with Sevier River, discharging into Sevier Lake.

The hydraulic resources of the company are very extensive and include the possible development of at least 132,000 continuous hp between existing points of diversion and return on the Bear, Logan and Provo Rivers, Battle Creek and Jordan River, including extensive developments in the Bear Lake district under rights secured from the government in 1907.

GRACE PLANT.

The largest and most recently completed plant on the system is located at Grace, Idaho, on the Bear River. This stream rises on the northern slope of the Uinta Mountains in Utah and after a circuitous route through Wyoming and Idaho it discharges into the Great Salt Lake. The annual high-water period occurs between May and July. At Grace 500 cu. ft. per second have already been developed, with a gross head of 513 ft. The plant is located on the edge of the river at the bottom of an escarpment, the river winding through a plain in a lava-walled chasm varying from 50 ft. to 250 ft. in depth. Mountains rise several thousand feet above the plain on both sides, forming the so-called Gentile Valley.

Water is diverted from the Bear River about 5 miles above the plant, at a point where the cliffs are low, the diversion being effected by a timber crib dam 38 ft. high, 75 ft. wide and 340 ft. long, with a 160-ft. spillway. Abutment walls extend 8 ft. above the crest. The forebay and intake are adjacent to the spillway on the east side of the dam, the former being formed by a recess in the river bank. A curtain wall parallel to the direction of the flow shuts in the forebay, deflecting ice and débris to the spillway. The curtain wall extends 15 ft. below the surface of the water and the forebay is covered by planking to afford protection against freezing.

INTAKE AND FLUME.

The intake, including a screen box, is cut into the dam with its bottom 15 ft. below the crest, and it terminates in a tapered intake pipe varying in diameter from 11 ft. 5 in. at the head to 8 ft. 6 in. at the lower end, the length being

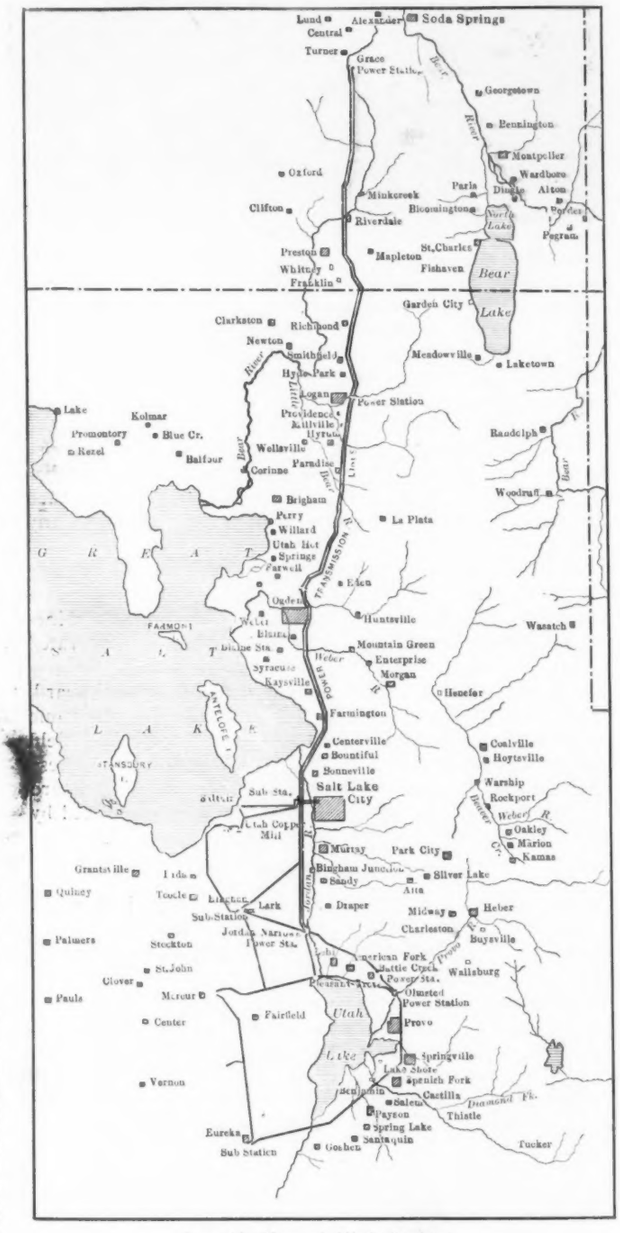


Fig. 14—Map of Utah System.

40 ft. The intake proper is about 33 ft. long x 15.5 ft. wide x 24 ft. high, the screen being made up in four sections of 1-in. x 6-in. planed lumber, with 1-in. spacers between. The intake pipe connects with a flow line having a total length of 23,221 ft., terminating in a 50-ft. x 76-ft. standpipe above the power plant. The upper 4157 ft. of the flow line is of wooden-stave construction, the pipe being of circular cross-section and 8.5 ft. in inside diameter, the material being Oregon fir. The stave line was built up on

the ground, the typical section consisting of forty-six staves from 3¼ in. to 3½ in. thick, hooped by ¾-in. rods spaced on the average 8 ft. apart. The stave line is supported on 6-in. x 8-in. timber chairs set 6 ft. apart. The rest of the flow line is composed of riveted steel pipe varying in diameter from 7.5 ft. to 8.5 ft., all piping being of ¼-in.

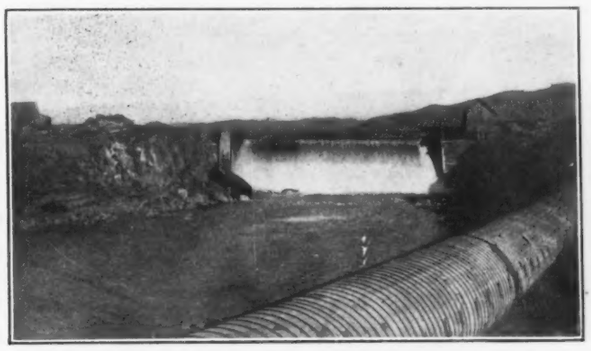


Fig. 15—Grace Dam and Wood-Stave Pipe.

Fig. 16—Grace Steel Flow Line.

steel plate. At each high point on the flow line a 10-in. air valve is installed, seven being required on the entire run. Four drain valves are installed at the low points of the line, these being from 8 in. to 10 in. in diameter and housed in concrete chambers with suitable wasteways.

The penstock is of steel, the diameter varying from 7.5 ft. at the upper end to 6.5 ft. at the lower, the plates being from ⅜ in. to 1 1/16 in. thick. The net head under full-load conditions is 440 ft. and the amount of water required to develop the full rating of the plant is 380 cu. ft. per second. The penstock terminates in a "Y-casting," from which branches lead to the turbine equipments, each branch being controlled by a 48-in. hydraulically operated gate valve. The tailrace is carried in a concrete tunnel under the middle of the station building.

TYPICAL STATION DESIGN.

The Grace power plant illustrates the company's standard hydroelectric generating station design when unrestricted by local conditions limiting the shape and arrangement of the installation. The general plan is to place all apparatus in a sequence, carrying the output of the equipment through the plant in as nearly a straight line as possible and proceeding from the waterwheel intakes to the outgoing transmission circuits with little or no reversal of direction. In addition, each generating unit and its corresponding electrical equipment and wiring, with switchboard control and high-tension apparatus, constitutes a complete station in itself, and can be operated either independently from or in multiple with the other apparatus in the plant. This arrangement also permits the symmetrical expansion of the plant when the load conditions demand enlarged facilities, and the absence of complications in arrangement tends to simplify the labor problem and render the installation much safer to operate than one in which the machinery and wiring are unsymmetrical.

BUILDING.

The Grace station building is of concrete fireproof construction, 60 ft. x 140 ft. inside, the north half being devoted to turbines, generators, low-tension apparatus and switchboard and the remainder to transfomers and high-tension apparatus. A 25-ton hand-operated Whiting crane serves the entire station. The foundations are of masonry carried to bed rock, and the foundations of the generating units are of concrete. The walls are braced by heavy buttresses on a 14-ft. spacing, and the roof, which is of ferro-inclave, cemented outside, is carried on steel trusses. Floors, stairways and internal division walls are all of concrete.

GENERATING UNITS.

Two turbo-generators are installed, each unit consisting of a 5500-kw, 2300-volt, three-phase, 60-cycle Westinghouse revolving-field alternator, directly driven on a horizontal shaft at 300 r.p.m. by an inward-flow Allis-Chalmers reaction turbine, the runners being of the double quarter-turn discharge type. Each turbine is rated to deliver 8500 hp under a head of 440 ft., with a discharge of 204 cu. ft. per second. Each runner is provided with two draft tubes, which are joined under the spiral casing of the machine and which discharge horizontally into the tailrace, 20 ft. beneath the center of the shaft. The guides form the gates of the runner and are of the swivel type. Two methods of operating the gates are available: First, by a hydraulic cylinder, and, second, by hand wheel and gearing. Relief valves are provided at the elbows of quarter-turns to protect the penstock from pressure fluctuations. The supply of water to the penstock is controlled by the gates and no governors are installed, as all slight load fluctuations are

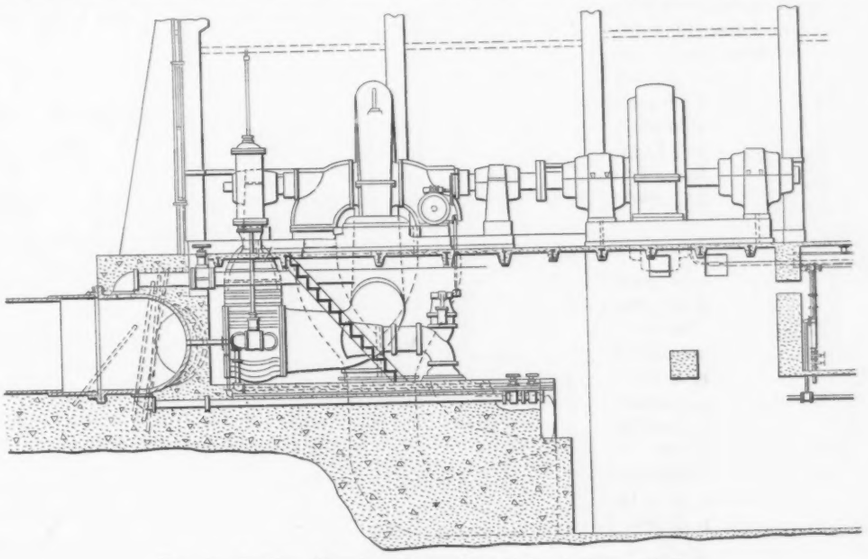


Fig. 17—Section Showing Generating Unit at Grace Station.

handled at Olmsted and Logan. Two 100-kw, 125-volt Westinghouse exciters are installed at the plant, each being provided with a 37-in. Pelton waterwheel for direct driving, the latter being served with water through a 10-in. pipe tapped into the "Y-casting" at the foot of the penstock. The permissible output of either exciter is more than 70 per cent greater than is needed for the two generators.

SWITCHING.

The plant has no main panel switchboard, pedestal equipments being used instead. From the generators the low-tension leads are carried between concrete barriers on the basement ceiling to the usual bus structure and switching equipment, the latter located on the operating-room floor. The leads are insulated with varnished cambric and carried on porcelain insulators. Five 3300-volt Westinghouse oil switches are provided, these being solenoid operated and fitted for remote control from the switching pedestals. Either generator may be operated upon a corresponding set of line transformers or paralleled on a common bus. Three control pedestals are installed, with corresponding instrument stands, one for each generator and corresponding line and a third for exciters and ordinary instrumental service. A small local-service switchboard of the panel type is in operation. The rheostats of the generators and exciters are operated by hand wheels in front of the control pedestals. The plant is provided with two water rheostats for maintaining the speed regulation in case of trouble on the system, these being lowered into the tail race for operation, and the two being capable of absorbing the total output of the station. Hand-wheel control, beside the pedestals, is provided for this apparatus.

HIGH-TENSION WORK.

Six 1833-kw transformers, with a seventh reserve unit, are installed on the basement floor level to raise the potential from 2300 volts to about 51,000 volts for the transmission of energy to the Logan station. The transformers of the water-cooled type are delta-connected on the low-tension side and star-connected on the high-tension side, and are arranged to allow operation at 88,000 volts. The high-tension equipment of the station has been designed and installed with this ultimate voltage in mind. Three 100-kw local-service transformers are also installed. High-tension leads and buses are insulated with varnished cambric and carried in tubes of fiber conduit supported on porcelain insulators and paraffined wooden pins set into varnished wooden framing. The high-tension leads from the transformers are carried about 8 ft. above the bushings to disconnecting switches mounted horizontally beneath the timber framing, and thence the leads drop to the oil-switch installation, which includes five 88,000-volt, remotely controlled equipments, located beyond the transformers on the basement floor and mounted in concrete cells. Disconnecting switches are also provided on the outer sides of the oil switches, and the company's standard practice is to locate all disconnectors on a horizontal axis inside stations, in order to avoid troubles arising from the falling open of the switch, with the added advantage of being able to open the circuit under certain conditions, as in the event of trouble arising in lightning arresters. Electrolytic lightning arresters and choke coils are provided between the oil switches and the outlet bushings of the station. The choke coils are of the solenoid type, consisting of a No. 3 rubber-covered wire wound upon a cylinder of fiber conduit 12 ft. long x 5 in. in diameter. The disconnecting switches have a 6-ft. break in each case. On the high-tension side of the station two oil switches control the outgoing lines; one switch controls each transformer, and the fifth is a tie switch for multiple operation of the two halves of the station. The high-tension lines leave the building through glass windows 4 ft. square, each wire being carried in a 2½-in. fiber conduit bushing with ozokonite filling, there also being an outer bushing 4 in. in diameter. A grounding device is installed outside the station, provision being made for the short-circuiting of each phase to the earth through a lever, bell-crank shaft and rotating-knife switch equipment operated from below. A galvanized-iron canopy extends outward from the station wall above the outgoing leads for a distance of about 6 ft., to deflect rain and snow from the outlet bushings.

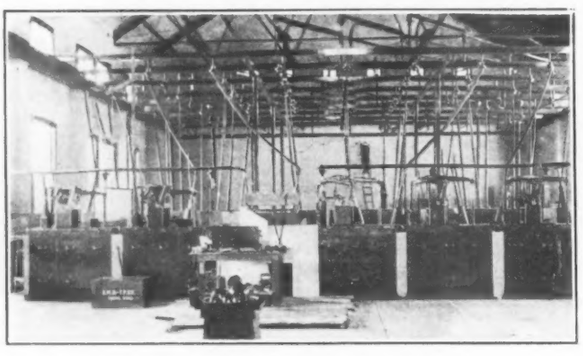


Fig. 19—Low-Tension Switches at Grace.

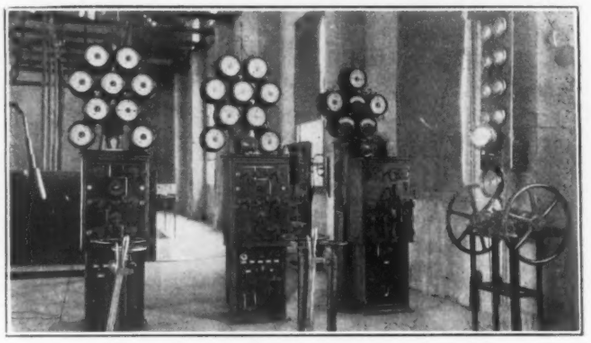


Fig. 20—Control Pedestals at Grace Station.

In following issues will be described other generating stations of the Utah system as well as the transmission systems.

THE CHARGING CURRENTS OF THREE-PHASE TRANSMISSION LINES.

Analysis of the Variations of Charging Currents When One Conductor Is Connected to Earth.

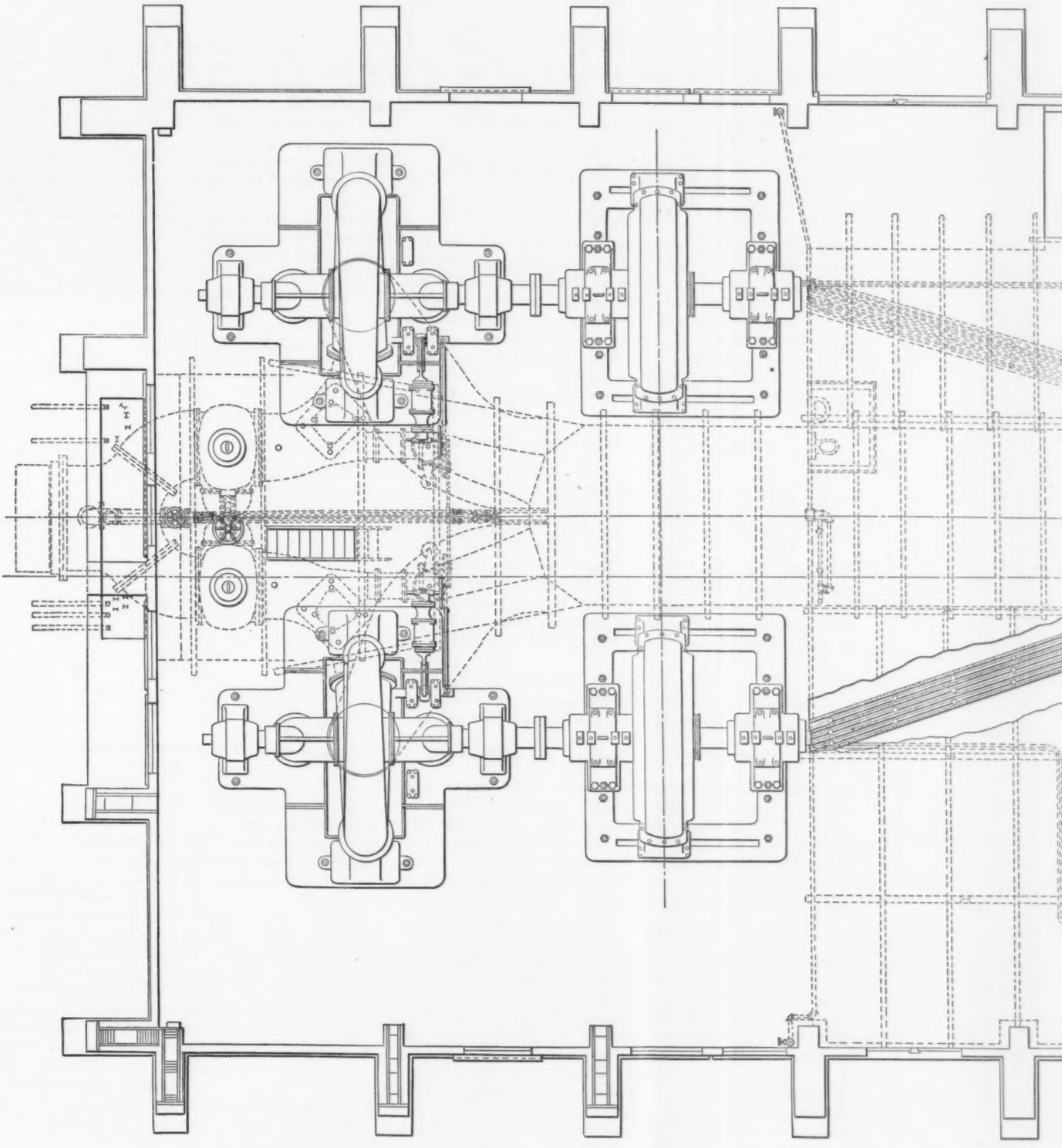
By George S. Humphrey.

THE usual formulas for calculating the charging currents of three-phase transmission lines are derived on the assumption that the conductors are placed at the vertices of an equilateral triangle and that the voltages to ground are balanced and equal. For any other arrangement of conductors or for any abnormal voltage conditions a solution can be reached only by resorting to fundamental principles. It is the purpose of this article to point out a method for calculating the charging currents when one conductor is grounded and to compare these values with the normal charging currents for certain common types of construction.

The ordinary formula for calculating the electrostatic capacity of a three-phase transmission line is

$$C = \frac{0.03883}{log_{10}\left(\frac{d}{r}\right)}$$

where C is the capacity in microfarads between one wire



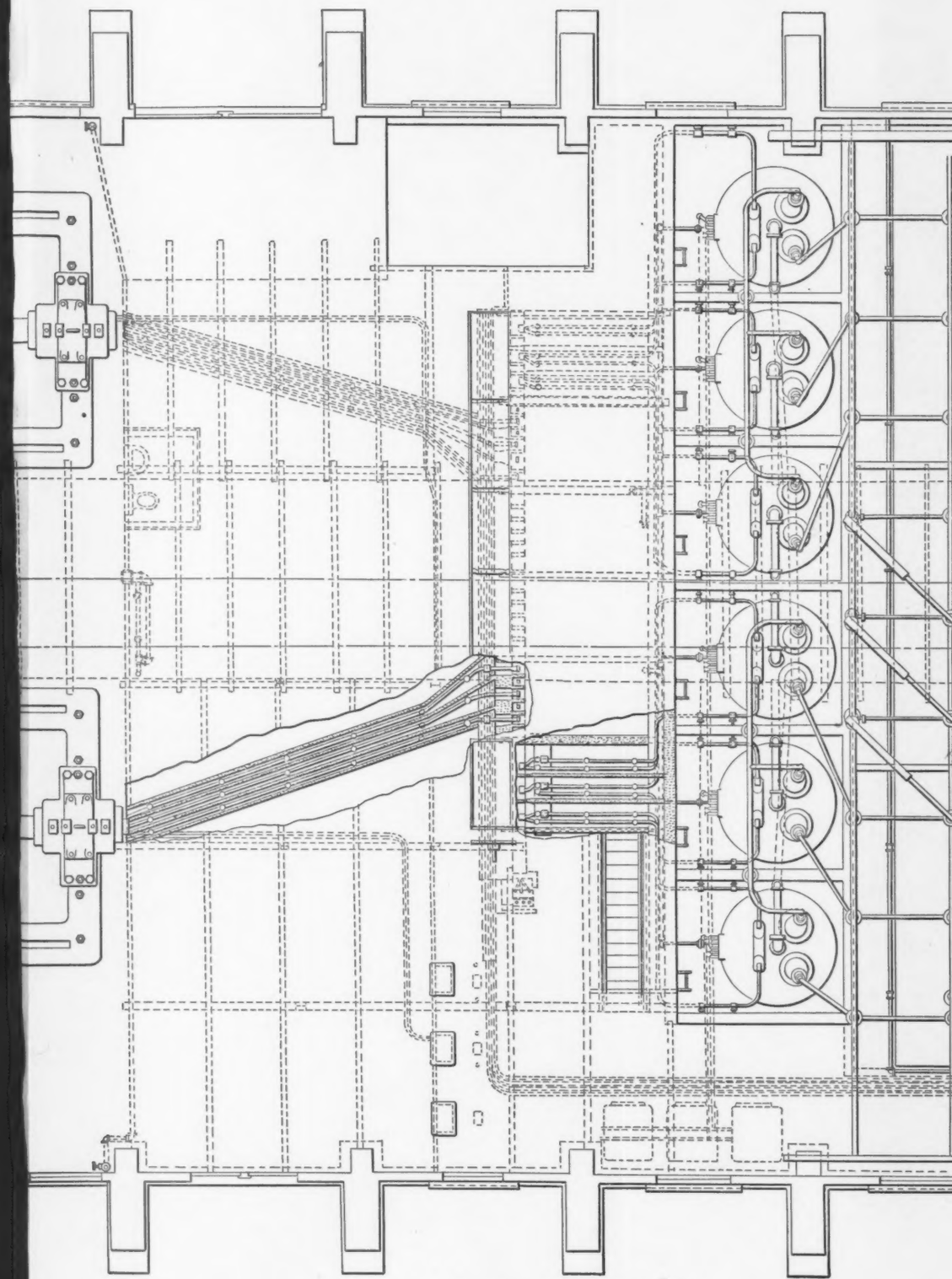
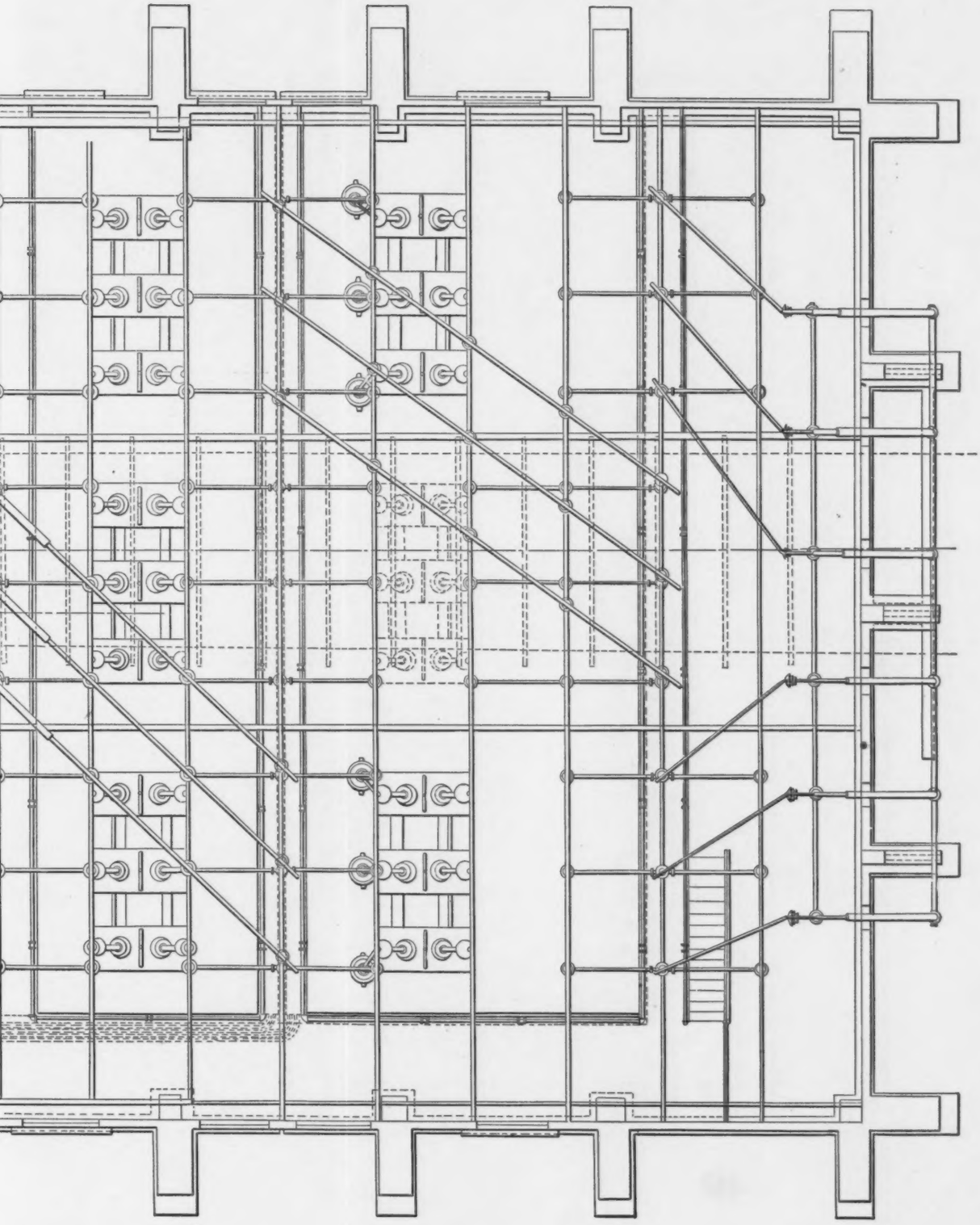


Fig. 18—Plan of Grace Power Station.



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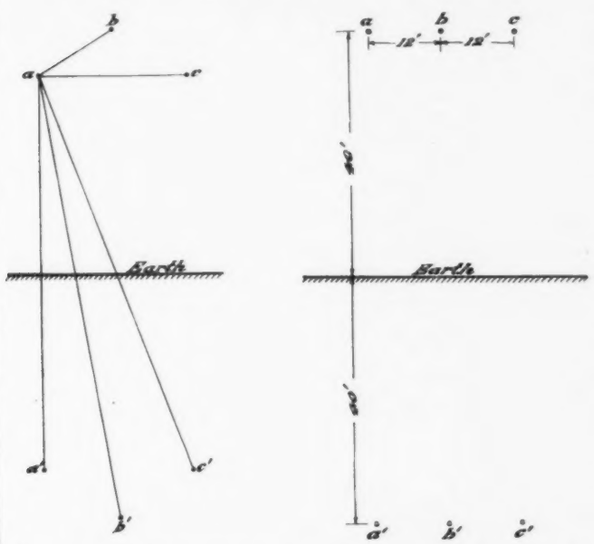
and ground per mile of line, d is the distance between the centers of the conductors, and r is the radius of the conductors. The charging current I per mile for each conductor is then

$$I = \frac{2\pi f C E}{10^6 \sqrt{3}}$$

where f is the frequency and E the line voltage.

Derivation of Equations.—The difference of potential between two points is defined as the work which must be done on a unit positive charge of electricity in moving it from the point of lower to that of higher potential. The work which is thus done on a unit charge against any neighboring charge Q is numerically equal to $2Q$ times the natural logarithm of the ratio of the initial to the final distance of the unit charge from Q.

Consider a three-phase transmission line with conductors a, b and c, as shown in Fig. 1. The distribution of potential in the field above the earth is the same as would exist if the earth were replaced by conductors a', b' and c' vertically under a, b and c, as far beneath the earth's surface



Figs. 1 and 2—Mechanical Arrangement of Real and Image Conductors.

as the latter are above it, and the charges on a', b' and c' were equal and opposite to those on a, b and c respectively. In the following discussion the earth will be replaced by three "images" of the real conductors, and the system treated as though it consisted of six conductors.

Let the distance from a to $b = ab$.
Let the distance from a to $b' = ab'$, etc.
Let the charge on conductor $a = Q_a$.
Let the charge on conductor $a' = -Q_a$.
Let the charge on conductor $b = Q_b$, etc.
Let the charging current for conductor $a = I_a$.
Let the charging current for conductor $b = I_b$, etc.
Let the potential of a above ground $= V_{ao}$.
Let the potential of b above ground $= V_{bo}$.
Let the potential of a above $b = V_{ab}$, etc.
Let the radius of each conductor $= r$.

The expression for the potential of a above ground, or V_{ao}, may be derived as follows: Move unit positive charge from a' to a. The work done against the charge on a is $2Q_a \log \frac{aa'}{r}$; against the charge on a' is $-2Q_a \log \frac{r}{aa'}$; against the charge on b is $2Q_b \log \frac{ab'}{ab}$; against the charge on b' is $-2Q_b \log \frac{ab}{ab'}$; against the charge on c is $2Q_c \log \frac{ac'}{ac}$; and against the charge on c' is $-2Q_c \log \frac{ac}{ac'}$. The potential of a above a' is the resultant work done against all of the charges, or $V_{aa'} = 4Q_a \log \frac{aa'}{r} + 4Q_b \log \frac{ab'}{ab} + 4Q_c \log \frac{ac'}{ac}$. Now $V_{ao} = \frac{1}{2} V_{aa'}$.

Dividing $V_{aa'}$ by 2 and solving for V_{bo} and V_{co} in the same manner,

$$V_{ao} = 2Q_a \log \frac{aa'}{r} + 2Q_b \log \frac{ab'}{ab} + 2Q_c \log \frac{ac'}{ac} \quad (1)$$

$$V_{bo} = 2Q_a \log \frac{ab'}{ab} + 2Q_b \log \frac{bb'}{r} + 2Q_c \log \frac{bc'}{bc} \quad (2)$$

$$V_{co} = 2Q_a \log \frac{ac'}{ac} + 2Q_b \log \frac{bc'}{bc} + 2Q_c \log \frac{cc'}{r} \quad (3)$$

These three independent equations can be used to solve for the three unknown charges if the voltages to ground are balanced and equal or otherwise known. This is not the case, however, unless the system is operated with a grounded neutral. But the voltages between lines can be taken as balanced and equal, and the charges can be determined by using line voltages instead of voltages to ground. In order to get an expression for the potential of a above b move unit charge from b to a. Proceeding as before and reducing results

$$V_{ab} = 2Q_a \log \frac{ab}{r}\frac{aa'}{ba'} + 2Q_b \log \frac{r}{ab}\frac{ab'}{bb'} + 2Q_c \log \frac{bc}{ac}\frac{ac'}{bc'} \quad (4)$$

$$V_{bc} = 2Q_a \log \frac{ca}{ba}\frac{ba'}{ca'} + 2Q_b \log \frac{bc}{r}\frac{bb'}{cb'} + 2Q_c \log \frac{r}{bc}\frac{bc'}{cc'} \quad (5)$$

$$V_{ca} = 2Q_a \log \frac{r}{ca}\frac{ca'}{aa'} + 2Q_b \log \frac{ab}{cb}\frac{cb'}{ab'} + 2Q_c \log \frac{ac}{r}\frac{cc'}{ac'} \quad (6)$$

In these equations there are three unknown quantities, Q_a, Q_b and Q_c, but only two independent equations, since the voltages between lines must add up to zero, and any one of the three equations can be derived from the other two. However, the charges must also add up to zero, so that

$$Q_a + Q_b + Q_c + \ldots = 0, \quad (7)$$

and this equation, together with any two of equations 4, 5 and 6, makes it possible to solve for Q_a, Q_b and Q_c.

The fractions $\frac{aa'}{ba'}$, $\frac{ab'}{bb'}$, etc., in the equations above are very nearly equal to unity and may be so considered for all practical purposes. Thus treating them does not lessen very much the work involved in the computations, however.

All potential differences and charges in the equations given above are expressed in fundamental electrostatic units. To reduce Q to coulombs per mile take logarithms to base 10 and multiply the results obtained from the equations by $\frac{3.883}{2} \times 10^{-8}$ when V is expressed in volts.

In calculating the unbalancing in voltage, etc., resulting from a grounded conductor it is necessary to know the relative time-phase of the charging current as well as its numerical value. In solving a problem it is most convenient to employ the complex expressions for the vector quantities, but the final results are more easily interpreted when converted to the trigonometric form.

A complete solution for any three-wire, three-phase circuit, with or without any conductor grounded, can be reached by a proper selection and combination from these seven equations. To illustrate the method the solution of a few typical cases will now be presented.

Illustrations.—(I) Suppose the conductors arranged as shown in Fig. 2. Flat spacing; a and c each 12 ft. from b; conductor, seven strands of No. 8 B. & S.; all conductors 40 ft. above ground.

(a). No conductor grounded. Normal. Use equations (4), (5) and (7).

$$V_{ab} = 3.883 \times 10^{-5} (2.87Q_a - 2.87Q_b - 0.287Q_c) = e \sin \theta \quad (4)$$

$$V_{bc} = 3.883 \times 10^{-5} (0.287Q_a + 2.87Q_b - 2.87Q_c) = e \sin (\theta - 120°) \quad (5)$$

$$Q_a + Q_b + Q_c = 0 \quad (7)$$

where V is in volts and Q in coulombs per mile. Solving

$$Q_a = 0.737 \times 10^{-5} e \sin (\theta - 27°)$$
$$Q_b = 0.809 \times 10^{-5} e \sin (\theta - 150°)$$
$$Q_c = 0.737 \times 10^{-5} e \sin (\theta - 273°)$$

Since it is usually desired to know the relative amount by which normal quantities are changed under abnormal conditions, and charging current is always the thing of most immediate interest, all final results will be expressed as the ratio of the true charging current to the value it would have under normal conditions as computed from the ordinary formulas.

According to the formula for electrostatic capacity $C = 0.0135$ microfarad per mile. $Q = CE$. Therefore $Q_a = Q_b = Q_c = 0.0135 \frac{e}{\sqrt{3}} = 0.780 \times 10^{-5} e$ coulombs per mile, each charge being in time-phase with its corresponding voltage to neutral.

Dividing the real values of Q_a, Q_b and Q_c by $0.780 \times 10^{-5} e$

$$Q_a = 0.94 \sin (\theta - 27°)$$
$$Q_b = 1.04 \sin (\theta - 150°)$$
$$Q_c = 0.94 \sin (\theta - 273°).$$

The charging currents are changed in the same ratio as the charges and lead them by 90 deg. Hence

$$I_a = 0.94 \sin (\theta + 63°)$$
$$I_b = 1.04 \sin (\theta - 60°)$$
$$I_c = 0.94 \sin (\theta - 183°).$$

Thus under normal operation the charging current of the middle conductor is 10 per cent greater than that of the side conductors. It is 4 per cent more than would be shown by the ordinary formulas, while that of the side wires is 6 per cent less than would thus be indicated.

From equations (1), (2) and (3) the voltages to ground may be found by using the values of Q_a, Q_b and Q_c just obtained. Expressing these voltages as the ratio of the voltage to ground to the balanced voltage to neutral:

$$V_{ao} = 0.98 \sin (\theta - 32°)$$
$$V_{bo} = 1.03 \sin (\theta - 150°)$$
$$V_{co} = 0.98 \sin (\theta - 268°)$$

The middle conductor has a voltage to ground 5 per cent greater than the side conductors.

(*b*) *Conductor a grounded.* The ground and conductor a now form one plate of the system of condensers, while b and c form the other two plates. Let Q_g represent the charge on the ground. The equations which must be used to express the physical conditions are:

$$V_{ab} = \ldots\ldots = e \sin \theta \quad (4)$$
$$V_{bc} = \ldots\ldots = e \sin (\theta - 120°) \quad (5)$$
$$V_{ao} = \ldots\ldots = 0 \quad (1)$$
$$Q_a + Q_b + Q_c + Q_g = 0 \quad (7)$$

Solving and expressing final results as before:

$$I_a = 0.38 \sin (\theta + 71°)$$
$$I_b = 1.35 \sin (\theta - 79°)$$
$$I_c = 1.31 \sin (\theta - 161°)$$
$$I_g = 1.64 \sin (\theta + 58°)$$
$$I'_a = I_a + I_g = 2.02 \sin (\theta + 61°)$$

I'_a is the total charging current which must be supplied to the grounded conductor on the generator side of the ground. From these results it is seen that when one of the side conductors is grounded its charging current on the side of the point at which it is grounded away from the generator is 38 per cent of normal. The charging current of the ungrounded side wire is 1.31 normal, and of the middle wire is 1.35 normal. The charging current supplied to the ground is 1.64 times the normal charging current of one conductor, and the total current supplied to the grounded wire at the generator end is 2.02 normal. The phase angles between the various charging currents are very much distorted. The charges on the ground and on the grounded wire are not in time-phase, because a is not placed symmetrically with respect to b and c.

(*c*) *Conductor b grounded.*—In this case the ground and conductor b form one plate of the system of condensers, while a and c form the other two plates.

$$V_{ab} = \ldots\ldots = e \sin \theta \quad (4)$$
$$V_{bc} = \ldots\ldots = e \sin (\theta - 120°) \quad (5)$$
$$V_{bo} = \ldots\ldots = 0 \quad (2)$$
$$Q_a + Q_b + Q_c + Q_g = 0 \quad (7)$$

Solving and reducing:

$$I_a = 1.37 \sin (\theta + 85°)$$
$$I_b = 0.50 \sin (\theta - 60°)$$
$$I_c = 1.37 \sin (\theta - 205°)$$
$$I_g = 1.73 \sin (\theta - 60°)$$
$$I'_b = 2.23 \sin (\theta - 60°)$$

When the middle conductor is grounded its charging current on the side of the point of ground away from the generator is 50 per cent of normal, and the total charging current which must be supplied to it at the generator end is 2.23 normal, as compared with 2.02 normal when a side wire is grounded. The charging current of the side wires is 1.37 normal, and that to ground is 1.73 times the normal charging current of one conductor. The charge on the ground is in time-phase with that on the grounded wire, since b is placed symmetrically with respect to the other two conductors.

To show the results for two other common types of construction and also to illustrate the effect of an overhead ground wire, two other arrangements of conductors will now be considered, namely, equilateral triangular spacing, with and without an overhead ground wire.

(II) Equilateral triangular spacing. Conductors 6 ft. apart and No. 0 B. & S.; vertex upward; base of triangle 25 ft. above ground.

The equations used in the preceding problem apply in the corresponding cases here. Only the results will be given.

(*a*) *No conductor grounded. Normal.*

$$I_a = 1.001 \sin (\theta + 9.9°)$$
$$I_b = 1.000 \sin (\theta - 60.0°)$$
$$I_c = 1.001 \sin (\theta - 179.9°)$$
$$V_{ao} = 0.99 \sin (\theta - 31°)$$
$$V_{bo} = 1.02 \sin (\theta - 150°)$$
$$V_{co} = 0.99 \sin (\theta - 269°)$$

(*b*) *Conductor a grounded.*

$$I_a = 0.52 \sin (\theta + 61°)$$
$$I_b = 1.29 \sin (\theta - 78°)$$
$$I_c = 1.32 \sin (\theta - 162°)$$
$$I_g = 1.43 \sin (\theta + 59°)$$
$$I'_a = 1.95 \sin (\theta + 60°)$$

(*c*) *Conductor b grounded.*

$$I_a = 1.33 \sin (\theta + 79°)$$
$$I_b = 0.53 \sin (\theta - 60°)$$
$$I_c = 1.33 \sin (\theta - 199°)$$
$$I_g = 1.47 \sin (\theta - 60°)$$
$$I'_b = 2.00 \sin (\theta - 60°)$$

(III) Same as (II) with a 0.25-in. ground wire strung 3 ft. vertically above conductor b.

The fundamental equations must now be revised to include the effect of the charge which is on the ground wire. Denote the ground wire by s and its radius by R_s. The equations are derived in the same manner as before, and when reduced are as follows:

$$V_{ao} = 2Q_a \log \frac{aa'}{r} + 2Q_b \log \frac{ab'}{ab} + 2Q_c \log \frac{ac'}{ac} + 2Q_s \log \frac{as'}{as} \quad (8)$$

$$V_{bo} = 2Q_a \log \frac{ab'}{ab} + 2Q_b \log \frac{bb'}{r} + 2Q_c \log \frac{bc'}{bc} + 2Q_s \log \frac{bs'}{bs}$$

$$V_{co} = 2Q_a \log \frac{ac'}{ac} + 2Q_b \log \frac{bc'}{bc} + 2Q_c \log \frac{cc'}{r} + 2Q_s \log \frac{cs'}{cs} \quad (10)$$

$$V_{ab} = 2Q_a \log \frac{ab}{r}\frac{aa'}{ab'} + 2Q_b \log \frac{r}{ab}\frac{ab'}{bb'} + 2Q_c \log \frac{bc}{ac}\frac{ac'}{bc'} + 2Q_s \log \frac{bs}{as}\frac{as'}{bs'} \quad (11)$$

$$V_{bc} = 2Q_a \log \frac{ca}{ba}\frac{ba'}{ca'} + 2Q_b \log \frac{bc}{r}\frac{bb'}{cb'} + 2Q_c \log \frac{r}{bc}\frac{bc'}{cc'} + 2Q_s \log \frac{cs}{bs}\frac{bs'}{cs'} \quad (12)$$

$$V_{so} = 2Q_a \log \frac{as'}{as} + 2Q_b \log \frac{bs'}{bs} + 2Q_c \log \frac{cs'}{cs} + 2Q_s \log \frac{ss'}{Rs} \quad (13)$$

$$Q_a + Q_b + Q_c + Q_g + Q_s = 0 \quad (14)$$

(*a*) *No conductor grounded. Normal.*

The proper equations are:

$$V_{ab} = \ldots\ldots = e \sin \theta \quad (11)$$
$$V_{bc} = \ldots\ldots = e \sin (\theta - 120°) \quad (12)$$
$$V_{so} = \ldots\ldots = 0 \quad (13)$$
$$Q_a + Q_b + Q_c = 0$$
$$Q_s + Q_g = 0$$

Solving and reducing results to the usual form:

$$I_a = 1.01 \sin (\theta + 60.5°)$$
$$I_b = 1.02 \sin (\theta - 60.0°)$$
$$I_c = 1.01 \sin (\theta - 180.5°)$$
$$I_s = 0.13 \sin (\theta - 240°)$$
$$I_g = 0.13 \sin (\theta - 60°)$$

The addition of the ground wire has increased the charging current of the side wires by 1 per cent and of the middle wire by 2 per cent. Without the ground wire the charging current of the side wires is a little more than that of the middle one, while the reverse is true when the ground wire is added. It is interesting to note that the current in the ground wire is 13 per cent of the charging current of a line conductor and is opposite in time-phase to the charging current of the middle wire. The ground wire and the ground together form a conductor on which charges are induced by the charges on the line conductors.

To find the voltages to ground, substitute the values of Q_a, Q_b and Q_c just found in equations (8), (9) and (10).

$$V_{ao} = 1.02 \sin (\theta - 28°)$$
$$V_{bo} = 0.97 \sin (\theta - 150°)$$
$$V_{co} = 1.02 \sin (\theta - 272°)$$

(*b*) *Conductor a grounded.*

$$V_{ab} = \ldots\ldots = e \sin \theta \quad (11)$$
$$V_{bc} = \ldots\ldots = e \sin (\theta - 120°) \quad (12)$$
$$V_{ao} = \ldots\ldots = 0 \quad (8)$$
$$V_{so} = \ldots\ldots = 0 \quad (13)$$
$$Q_a + Q_b + Q_c + Q_g + Q_s = 0$$

Solving and reducing:

$$I_a = 0.45 \sin (\theta + 59°)$$
$$I_b = 1.44 \sin (\theta - 81°)$$
$$I_c = 1.35 \sin (\theta - 159°)$$
$$I_s = 0.53 \sin (\theta + 74°)$$
$$I_g = 1.19 \sin (\theta + 56°)$$
$$I'_a = I_a + I_s + I_g = 2.17 \sin (\theta + 61°)$$

(*c*) *Conductor b grounded.*

$$V_{ab} = \ldots\ldots = e \sin \theta \quad (11)$$
$$V_{bc} = \ldots\ldots = e \sin (\theta - 120°) \quad (12)$$
$$V_{bo} = \ldots\ldots = 0 \quad (9)$$
$$V_{so} = \ldots\ldots = 0 \quad (13)$$
$$Q_a + Q_b + Q_c + Q_g + Q_s = 0$$

Solving and reducing:

$$I_a = 1.35 \sin (\theta + 80°)$$
$$I_b = 0.44 \sin (\theta - 60°)$$
$$I_c = 1.35 \sin (\theta - 200°)$$
$$I_s = 0.30 \sin (\theta - 60°)$$
$$I_g = 1.33 \sin (\theta - 60°)$$
$$I'_b = I_b + I_s + I_g = 2.06 \sin (\theta - 60°)$$

Without the ground wire the maximum charging current with a grounded conductor is 2.00 normal and occurs when the middle wire is grounded. With the ground wire the maximum charging current is 2.17 normal and occurs when a side wire is grounded.

Increasing the number of conductors involved adds greatly to the complexity of the equations, but the same theory applies in any case.

Summary.—A grounded conductor produces about the same relative effect for all types of construction which are used in practice. In general, with one conductor grounded the charging current of the two ungrounded conductors becomes approximately 1.35 normal and that of the grounded conductor on the side of the ground away from the generator approximately 0.50 normal; the total charging current which must be supplied to the grounded conductor is approximately 2.10 normal.

THICKNESS OF ELECTRIC AND THERMAL INSULATION.

Determination of the Relative Thicknesses of Insulation for Different Cores in Order to Retain the Same Resistance and Same Dielectric Strength.

By Carl Hering.

WHEN a wire of circular section is covered with a layer of insulation problems concerning the so-called insulation resistance may involve the calculations of the resistance of the insulation, hence of a tube or hollow cylinder from the inside cylindrical surface to the outside one. The length of the path of the current, therefore, is the thickness of the insulation, and the cross-section of the path is a cylindrical one varying from the smaller inside surface to the larger outside one; that is, it is not constant, but flares. The same problem occurs in the thermal insulation of steam pipes, cylindrical boilers, cylindrical electric furnaces, etc.

The question therefore arises, What shall be taken as the correct average cross-section in the calculations? It can readily be shown that the usual rough rule, to take the ordinary arithmetical average between the inside and outside, is not rigidly correct, and in fact is quite erroneous when the flare is great, as, for instance, in the case of a thick insulation on a small wire. It should be used only for thin layers on large diameters, and even then it is only approximate.

Owing no doubt to the fact that the correct formula is not readily found in books and that, as given by physicists, it involves so-called natural or Naperian logarithms, which are troublesome and not readily available, calculations of this kind are not made as often as they ought to be in order to proceed more intelligently in making specifications, and the lack of such calculations may at times lead to quite erroneous conclusions. For instance, in a recent case in the writer's practice a specification was found to call for two sizes of rubber-covered wire. The thickness of insulation of the larger one was required to be 40 per cent greater than that of the smaller one, and this greater thickness was supposed to give it a correspondingly better insulation, as the insulation called for was also about 40 per cent greater. The same quality of insulation was implied because the mechanical test was the same for both. Calculations with the correct formula, however, showed that, notwithstanding the greater thickness of the rubber, the insulation resistance would not only not be greater but would be actually less than with the thinner one. The explanation is in part that the surface of the core of the larger wire was considerably more than 40 per cent greater; hence this more than counteracted the increased thickness of insulation. This shows that it is sometimes advisable

to make the correct calculations, as the conditions may be deceptive.

The purpose of the present article is to point out and discuss some of the results obtained from the rigidly correct formula, and to show those who may shrink from attempting to use formulas containing unfamiliar factors that it is not at all a difficult one to use.

The rigidly correct formula for such cylinders, as deduced by the physicist, is

$$R = \frac{r}{2\pi L} \text{ nat. log. } \frac{D}{d}, \qquad (1)$$

in which R is the total resistance in ohms, r the specific resistance (resistivity) in ohms per centimeter or inch cube, L the axial length of the cylinder, D the outside diameter and d the inside diameter, all three in centimeters or inches. Of course, either inches or centimeters must be used consistently throughout. R and r may both be in megohms or in thermal ohms* in the case of thermal insulation.

As tables of the common logarithms are generally more readily accessible and more familiar to work with, this formula is best reduced to the following simple form:

$$R = 0.366468 \frac{r}{L} \text{ com. log. } \frac{D}{d}. \qquad (2)$$

For routine calculations this could be further reduced to avoid uncomfortably large numbers. The fraction D/d will always be greater than unity, hence will never involve the troublesome negative coefficients. The last factor "common logarithm D/d" merely means that the logarithm of the quotient of D/d should be used and not the quotient itself. This, of course, requires to be found from tables. Those familiar with logarithms will subtract the log. of d from the log. of D, and the result will be the desired figure. Many useful deductions can, however, be made without using logarithms at all.

For instance, if two wires of different sizes are to have the same insulation resistance per mile, or if two different steam pipes are to be equally well insulated thermally, so that the loss of heat is the same—that is, if R remains the same, as well as r and L—it follows from the formula that the quotient of the outside diameter of the insulation divided by the inside diameter must always be the same. Fig. 1 shows graphically how greatly the thickness of the insulation must therefore increase when the cores increase in diameters from 1 to 2, 3, 4 and 5, the smaller one representing about 13/64 in. thickness of insulation on a No. 10 B. & S. core, the outside diameter being therefore five times that of the core; hence $D/d = 5$. For convenience the deductions will here be given in terms of the diameter of the smallest wire taken as unity. Although the thickness of the insulation of the larger one is five times as great as that of the smaller, the insulation resistance is only the same. This shows that it becomes very expensive to insulate the larger wires to the same insulation resistance as the smaller ones.

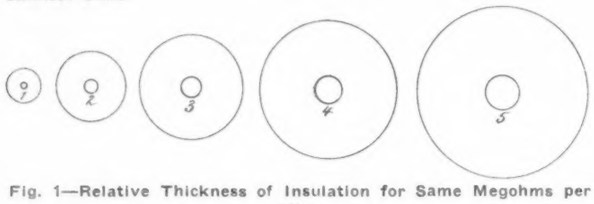


Fig. 1—Relative Thickness of Insulation for Same Megohms per Mile.

In order to show how rapidly the cost of the insulation increases let it be assumed that the insulation of the larger wire is made 25 per cent less. Then, from the formula, log. D/d must be 25 per cent less. Originally $D/d = 5$ hence log. $5 = 0.69897$; three-quarters of this is 0.52423, hence this is the log. of D'/d, in which D' is the new diameter. As $d = 5$, add the log. of 5 to this latter log., giving 1.22320; the number for which this is the log. is 16.72, which is therefore the outside diameter when the insulation is 25 per cent less. This is shown in the outer dotted circle in Fig. 2, the outside diameter having formerly been 25. The thickness of insulation has therefore been reduced from 10 to 5.86, or nearly as much as one-half.

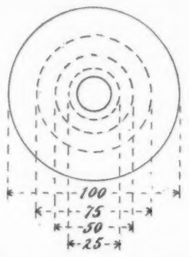


Fig. 2—Relative Diameters for Various Percentages of Insulation.

But the saving in amount of insulation material is far greater. The cross-sectional areas of the insulation in the two cases are 471.4 and 198.9; the former is therefore 237 per cent of the latter. Hence this 25 per cent dilfference in insulation resistance requires much more than double the material of the lower resistance wire. Or, in other words, to allow a reduction of only 25 per cent in the resistance reduces the required insulation material to considerably less than half. This slightly higher insulation is therefore dearly bought.

Making these same calculations for one-half the original resistance reduces the outside diameter to 11.18, as shown by the middle dotted line in Fig. 2. The thickness of the insulation is then reduced from 10 to 3.09, or to less than a third; and the section of the insulation will then be 78.6, or just one-sixth. That is, there is a saving of five-sixths of the insulation material if the insulation resistance is reduced to one-half; or, in other words, it takes six times as much material to double the insulation resistance of that wire.

Again, repeating the calculations for a reduction to one-quarter of the original gives an outside diameter of 7.48, as shown by the smallest dotted circle. The thickness is then reduced from 10 to 1.24, or to one-eighth, and the cross-section to 24.2, or to nearly one-twentieth of the original. That is, to increase the insulation by 300 per cent requires twenty times the amount of insulation material in this case.

In view of the above it seems to be unnecessarily extravagant to specify the same high insulation for larger wires as for smaller ones when the insulating material is expensive, like rubber. The leakage of energy through such high insulation is certainly not worth such expense to save, hence it cannot be the criterion. For a 20-mile circuit of No. 6 cable of 2000 megohmns per mile, with 6000 volts, the leakage loss is only about one-third of a watt.

If it is thought that this leakage gradually deteriorates the insulation and should therefore be small, then it would

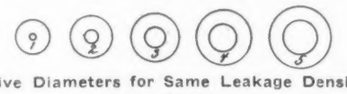


Fig. 3—Relative Diameters for Same Leakage Density or Break-Down Voltage.

be more rational to allow the same leakage current per square inch of inside surface of the insulation for large and small wires. This would mean approximately the same thickness of insulation for all sizes and would reduce the allowable insulation resistance very greatly for larger cables. In fact, the insulation would then actually be slightly thinner for the larger wires. On this basis the insulation would be about as shown in Fig. 3.

*"Thermal Resistance and Conductance; the Thermal Ohm and Thermal Mho." By Carl Hering. *Metallurgical and Chemical Engineering*, Jan., 1911, p. 13.

For high voltages it would seem that the thickness of insulation of large wires would be governed more by the breakdown test than by the insulation resistance, and in that case the thickness of insulation would again be equal for large and small wires for the same voltage, as in Fig. 3.

If mechanical considerations govern the thickness, it may be cheaper to strand the wire, or if stranded to use thinner strands, so as to make it more flexible.

In the thermal insulation of steam pipes the only two factors are the value of the energy of the steam saved and the cost of the insulation necessary to save it. When the present writer published a discussion of this and other similar rigid formulas some years ago a foreign steam engineer in applying them to the customary practice in steam-pipe insulation in this country found the commercially interesting fact that the insulation was too thick, as the steam energy saved by the excessive thickness did not warrant the cost; that is, a somewhat thinner insulation would be more economical when both the factors were considered.

Returning again to Fig. 1, the current-carrying capacities of the cores may be assumed to be proportional to their cross-sections. Dividing the cross-sections of the insulation by that of the wire, in each of those five cases, gives a constant, in this case 24; that is, the volume of the insulation is twenty-four times that of the wire core. This means that when the insulation resistance is the same for different sizes of wire the amount of insulation increases in the same proportion as the cross-section of the wire; that is, for a given insulation resistance the weight of insulation per circular mil of the core is the same for all sizes. It can be shown mathematically that this follows directly from the above formula. There is therefore no insulating material saved by using one large wire instead of two smaller ones which together equal the larger one in cross-section of copper.

When, however, the thickness of insulation is the same for all sizes of core, as shown in Fig. 3, in which it is governed not by the megohms per mile but by equal breakdown voltages or by approximately equal current densities of the leakage through the insulation, as above described, then there will be very considerable savings of insulation material as the wire becomes larger. The amount of insulation then increases approximately as the diameter (accurately it increases slightly less than the diameter), hence as the square root of the circular mils. A wire of twenty-five times the section, as in Fig. 3, would therefore require only about five times the weight of insulation, instead of twenty-five times, as in Fig. 1.

Another use which can be made of the above rigid formula is to find the correct specific resistance (resistivity) of the insulation material from the megohms per mile of a wire of given size and insulation thickness.

One has merely to substitute the known values for, say, 1 mile or 1 ft. and solve for r.

For instance, a No. 10 B. & S. okonite wire with 5/32-in. insulation is said to have an insulation resistance of 5300 megohms per mile. Hence, using megohms for both R and r, and inches for the length: $R = 5300$, $L = 5280 \times 12 = 63{,}360$; $D = 0.4144$; $d = 0.1019$; common log. $D/d = 0.60959$. Hence: $r = 5300 \times 63{,}360 \div (0.36647 \times 0.60959) = 1{,}500{,}000{,}000$ megohms for a cube of the material having sides 1 in. in length.

Central Station
Management, Policies and Commercial Methods

USING ELECTRICITY ECONOMICALLY.

The Union Gas & Electric Company, of Cincinnati, in its new magazine bearing the curious title *?—and the Answer*, makes a point of educating its customers in the economical use of its service. Following are some of the pertinent phrases used as running heads across the pages: "Every lighted lamp not actually utilized robs you." "Always extinguish lamps when leaving the room." "Neighbors can't remedy your complaints; tell us." "When a lamp gets smoky renew it." "An unoccupied room needs no lighted lamp." "Don't bore your friends with complaints; tell us." "It's easy to turn off a lamp and it saves money." "Bring your troubles to use; others can't help you."

DECORATIVE STREET LIGHTING IN LOUISVILLE.

The marked success which has been secured by those interested in the erection of ornamental illuminating standards in the business district of Louisville has created much enthusiasm among the merchants. A permanent organization of retailers along Market Street, from Second to Seventh Street, upon which the standards are now being erected, following their adoption on two blocks of Jefferson Street recently, is to be formed, and a celebration of the opening of the Market Street "white way" is being planned. An electric carnival has been suggested, and it is expected that this idea will be taken up in a definite way in the near future. The desire on the part of the merchants to improve their thoroughfare, which was created by the "white way" project, has extended to other branches of work, and the questions of street-railway facilities, better paving, etc., are now being discussed as well.

PORTABLE CENTRAL-STATION SERVICE.

A resident of Brooklyn, N. Y., whose factory is supplied with energy from the mains of the Edison Electric Illuminating Company lives in one of the suburban districts of the city at a considerable distance from the present lighting mains. In order to have electric light from the company this enterprising customer goes to his office each day in his electric runabout, puts spare batteries on charge on the central-station system until the day is over, and then hastens home in the electric vehicle, connects the batteries to the house-wiring system, and sits down to enjoy the evening in his electrically lighted home.

WHY THE MOTOR SAVED OVER THE GAS ENGINE.

The owner of a grain elevator at Mount Morris, Ill., which had been operated by a gas engine, found himself suddenly in need of additional power, and Mr. L. R. Spaulding, the local electrical manager, was asked to estimate the cost of installing and operating a motor. He was told that the 7½-hp gasoline engine was run continuously ten hours each day, but when he submitted his motor estimate based on this performance the elevator operator objected that the cost of electric drive was out of the question in view of the cheaper operation of the gas engine.

Unable to understand the difference, the central-station man went down to look over the outfit. To his surprise he found that the actual load involved lasted only three minutes at a time, at long intervals. But on account of the difficulty of starting the engine was perforce allowed to run continuously during the day. Correcting the first estimate, a new proposition was then submitted to the elevator owner,

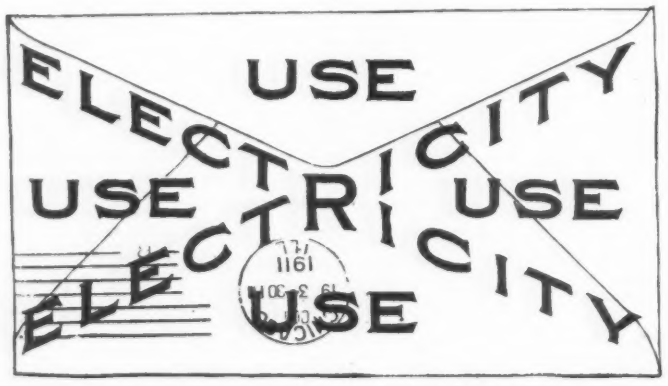
who authorized the installation of a 15-hp motor. While this machine is perhaps unnecessarily large for the load it carries, its surplus rating is often of value for starting a stalled or jammed load on the elevator. The cost of operating this 15-hp motor just about equals the cost of the kerosene formerly burned in stoves to keep the gas-engine outfit warm enough to run.

CENTRAL-STATION ELECTRIC TRUCK.

The Kentucky Electric Company, of Louisville, has purchased and is putting into service a 1-ton electric truck, manufactured by the Kentucky Wagon Manufacturing Company, of Louisville. The truck is equipped with an express body and will be used by the distribution department for lamp deliveries and general emergency purposes. As it is one of the few electric trucks in Louisville, it is believed that it will serve as an advertisement for the electric vehicle generally and indirectly develop new business for the company. The equipment of the truck for use in trouble calls is somewhat out of the ordinary, including a blower operated by an independent motor attached to the storage battery of the vehicle, the blower being taken into manholes for the purpose of supplying fresh air and driving out foul air during the operations of the workmen. This is expected to prevent accidents and to increase the efficiency of the workmen. Electric lamps lighted from the storage battery will be carried into manholes.

"USE ELECTRICITY."

Mr. W. E. Clement, contracting agent for the New Orleans Railway & Light Company, does not let an opportunity pass to remind even those to whom he addresses



Back of Envelope Used for Advertising Purpose.

business correspondence to "use electricity." Herewith is reproduced the back of the envelope used by the commercial department of the New Orleans company, which tells its own story in big red letters.

A LARGE PUMPING MOTOR LOAD FOR THE OMAHA COMPANY.

The Omaha Electric Light & Power Company, of Omaha, Neb., is now negotiating with the Union Stockyards Company, of South Omaha, for electric pumping of its water supply, offering a rate for this service that will effect an enormous saving over the present cost of purchasing water from the city. The packing industries in the Union Stockyards district use about 11,000,000 gal. of water daily, at the present time paying the city 4.5 cents 1000 gal. The central-station company offers to deliver this quantity of water from wells, against a total head of 300 ft., at 1.35 cents per gal.

The source of this water supply will be sixty or seventy wells, 40 ft. to 60 ft. deep, from which the water will be lifted by compressed air into a low-level compensating reservoir. About 200 hp in motor-operated compressors will be required to furnish the compressed air for these air-lifts. From the compensating reservoir at the level of the river bank three or four direct-connected, motor-operated centrifugal pumps will thence raise the water through a vertical height of 250 ft. to the distributing reservoir on the hilltop, from which it will be supplied to the stockyards consumers by gravity. The pumping station will have a capacity for delivering 7000 gal. of water per minute, and will require a total equipment of 750 hp in motors.

NEWSPAPER CENTRAL-STATION PUBLICITY.

Several electric companies in Tennessee have been using more than an average amount of newspaper publicity in creating general good-will and securing new business. Among the prominent companies which are doing advertising work are the Chattanooga Railway & Light Company and the Nashville Railway & Light Company.

The former used recently a page display in which the work of the company was discussed and the various phases of its service referred to. The company stated that it is now lighting 5500 homes in Chattanooga. The development of electric specialties is indicated by the fact that 2200 electric irons are in use. Ninety electric signs are installed, all lighted by the company, and electric power is being served to the extent of 3340 hp. One manufacturer recently contracted for 800 hp. The Nashville central station featured in a recent display advertisement the fact that President Taft, during his recent visit to Nashville, turned the current into a big sign which carries the legend "Nashville Offers Opportunity," which has been adopted as the official slogan of the business organizations. In this connection it exploited the value of electric signs from a publicity standpoint. "The electric sign identifies your place of business—it burns your name into the minds of the people," the company declared.

ONE CENTRAL STATION'S "UPLIFT" POLICY AMONG ITS FARMER FRIENDS.

As already noted in these columns, the Liberty Light & Power Company furnishes electric-lighting service from its 32 miles of 13,200-volt and 6600-volt transmission lines to a number of farmers in the vicinity of Richmond and Liberty, Ind.

As the result of his experience with this class of service, Mr. Robert S. Ashe, president and manager of the company, declares that the farmer is hardly to be regarded as a profitable customer, since, indeed, such service has not paid its way financially even when the farmer furnishes all construction material, transformers, etc. The farm owners in the neighborhood of Liberty and Richmond are very prosperous, but at this time they are using their electric service only for lighting. Their characteristic thrift and economy apply equally well to their consumption of kilowatt-hours, and as a result their bills usually run quite low. The company makes a minimum "transformer-loss" charge of $1 a month for each customer. During the winter months, however, some of the farm bills average $2 to $2.50, the rate for energy being 13 cents per kw-hour. Tungsten lamps are used for general illumination in the farmhouses, the commoner carbon lamps being employed in the barns and outbuildings.

While the lines of the Liberty company were not built especially for the supply of electricity to farmers, Mr. Ashe has been disposed to take the broad and altruistic viewpoint that, to accommodate his farmer friends, connection wherever it is possible shall be made to his lines. "In doing this," he says, "we have brought great comfort and happiness to many people, and we feel that our reward is ample in the relief of so many of our friends from a part of the drudgery with which their lives are so fully surrounded.

"When we have the lighting business well developed in the towns which we serve we hope to devote a part of our time to the farms, because of the general uplift it will be to the entire community which we serve."

ELECTRIC HEATER AIDS PRINTER ON RUSH JOBS.

For drying "rush" work rapidly so that it can be delivered or made ready at once for printing on the other side without offsetting, the Bradley & Gilbert Company, printer, of Louisville, Ky., makes use of a drying cabinet containing a 770-watt Quartzlite heater. This heater sits in the lower compartment of the 5-ft. x 3-ft. case, and above it, on a light tray of wood slats, the sheets to be dried are placed. Work which would require lying undisturbed twenty-four hours at ordinary room temperatures is thoroughly dried in the cabinet in thirty to sixty minutes and is then ready for handling of any kind. Twenty-five or fewer sheets may be laid on top of each other without offsetting in the drying cabinet and, of course, this drying space could be increased without additional expense by multiplying the number of trays.

So much printing work is required on a rush basis that such an electric drying cabinet would seem to be a valuable addition to any but the smallest shops. And with such a dryer even the little job-work man might establish a reputation for quick delivery that would make his cabinet a paying investment. The Louisville application was suggested by Mr. A. T. Macdonald, general traffic manager of the Louisville Lighting Company, whose attractive monthly, *Chained Lightning*, is printed in this shop.

DES MOINES MODERN FIREPROOF CENTRAL-STATION STOREHOUSE.

Not a single stick of wood or other inflammable substance has entered into the construction of the modern new fireproof storehouse of the Des Moines Electric Company, completed this year at a cost of $35,000. The building is of brick, steel and concrete, and even the window sash, frames and doors are entirely of metal. This building, like several others recently described in the *Electrical World*, is significant of the increasing attention given to the proper storing of supplies and materials. In many plants some ill-adapted corner of the power house, or perhaps a former stable, is often utilized for this important purpose, but central-station operators are now coming to recognize the position of the storeroom as being second only to that of the plant and offices.

The Des Moines storehouse building is three stories in height, but is designed for two additional floors. The rear of the lower stories is occupied by the substation. As shown in Fig. 1, the front of the building has been made attractive by the use of white-tile ornamentation to set off the brick. The arch shown has been prepared with the future possibility in view of converting this opening into a plate-glass store front, should it later become desirable. To this same end the floors and ceilings are of unit concrete construction, and can be unbolted and removed to form a fourth story if desired. Similar provision is made for enlarging the substation at the rear. For the accommodation of a third motor-generator set (space is already left for the second, yet uninstalled) the tile partition can be moved

Fig. 1—Modern Fireproof Central-Station Storehouse in Des Moines.

forward 20 ft., the steel work being already in place for the continuation of the overhead-crane runway.

The building is entered from the street through the doorkeeper's office and also through a driveway opening. The latter areaway is separated from the storeroom by a partition of heavy wire netting. This partition, like those on the other floors, is built in sections bolted in place and can be taken down or changed as desired. On the first floor are stored line material, hardware, hangers, conduit, etc. The shelves are all of steel sheeting supported on steel angles, and are built in 10-ft. lengths, so that they can be shifted or moved as required. On the same floor are a toilet and the lockers for the men. These lockers, built of

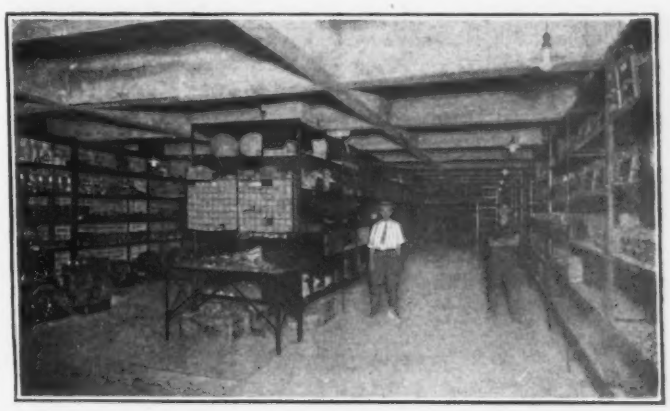


Fig. 2—Interior Second-Floor Storeroom, Des Moines Electric Company.

sheet steel on angle sections, with screen backs for ventilation, measure 14 in. wide, 12 in. deep and 6 ft. high. They are assigned to the storehouse employees, trouble men and gang foremen.

The upper stories are reached by both a steel stairway and a freight elevator, each inclosed in a separate brick well

with fireproof steel doors opening upon the floors. The elevator is especially spacious, measuring 6 ft. x 10 ft., and has a capacity for lifting three tons. It is completed through to the future fourth story.

The second-floor storeroom is occupied by motors, starters, heating appliances, meters, arc lamps, incandescent lamps and glassware. A large stock of direct-current motors is carried, and about 500 meters are continually kept on hand. The racks for this material are all of steel, built in 10-ft. lengths on the floor below. The corner pieces are 1½-in. x 1½-in. x 3/16-in. angle steel, across which are bolted 1-in x 1-in. x 3/16-in. angles as framing for the No. 16 sheet iron forming the shelves. There are six shelves per rack, each 16 in. high and 20 in. deep. The glassware racks are similarly constructed, but are 40 in. deep. The arc lamps are hung on 1¼-in. pipes carried on 1½-in. x 2-in. x 3/16-in. angle framing. These racks are similarly in 10-ft. sections, 4 ft. wide, the pipes being at distances of 1 ft., 2 ft. and 1 ft. respectively, at levels 3 ft. and 6 ft. above the floor.

The front of the room is used for drafting, and alongside the elevator are a toilet and shower bath for the use of the men.

On the third story are the arc-lamp and meter-test rooms, separated by a screen partition from the storage section for unbroken-package material, transformers, etc., which extends over the substation occupying the floors below.

The substation contains a 1000-kw, 6600-volt synchronous motor-generator set, producing 230-volt direct-current energy for the three-wire system, the neutral point of which is established by a balancer set near by. The substation interior is attractively finished in light tile and is served by a hand-operated crane. Beneath the station is a brick-lined tunnel conveying the cables from the alley conduit, and also containing the machine rheostats, remote-controlled oil switches, etc. The building is heated by a low-pressure steam boiler in the basement. The lighting is done by 60-watt tungsten lamps with refracting shades. All wiring is in conduit, which is laid in the concrete of walls and ceilings.

Mr. P. B. Sawyer is general manager of the Des Moines Electric Company. The various features of the new storehouse that have been described in this article were designed by him.

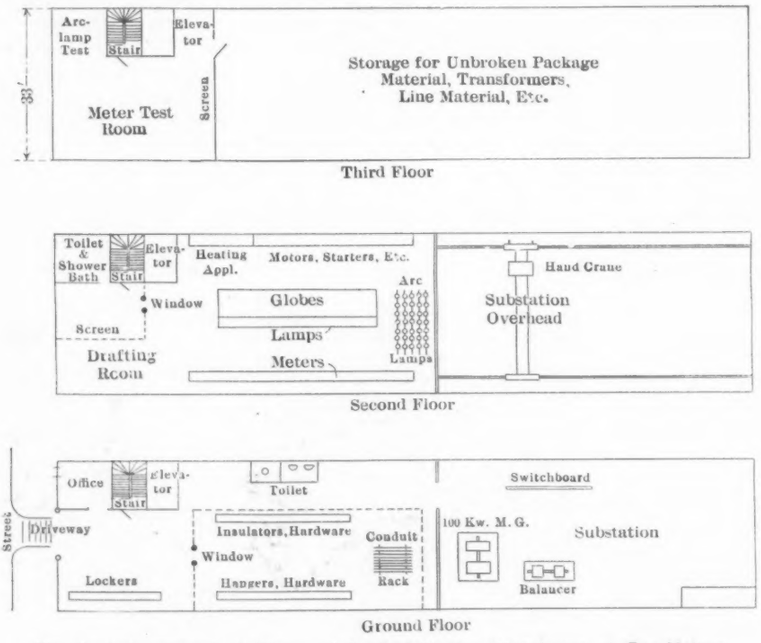


Fig. 3—Arrangement of Floors of Central-Station Warehouse at Des Moines.

Wiring and Illumination

THEATER LIGHTING.

Mr. Francis A. Vaughn, of Milwaukee, presented an elaborate paper on "Theater Lighting" at the meeting of the Chicago Section of the Illuminating Engineering Society on Nov. 16. Mr. Vaughn was assisted by Mr. G. H. Cook in the preparation of the paper, which was a general survey of the requisites of theater lighting, both for exterior and interior illumination. It was illustrated by a large number of photographs and drawings.

Referring to exterior illumination, Mr. Vaughn contrasted the handsome, dignified exteriors of the principal theaters of the continent of Europe with the more meretricious, sign-studded theater buildings in this country. He said that in the United States there is possibly a tendency toward obnoxious glaring treatment of this subject.

Exterior lighting consists of what is termed "attraction" lighting, decorative lighting and utility lighting. As far as the decorative effects are concerned it would seem to be better to use concealed-light sources illuminating the architectural features rather than lamp-studded designs. The "Butterfly" theater in Milwaukee was referred to as an example of elaborate exterior design in electric lamps, and the speaker intimated that a more effective and artistic result might have been obtained, perhaps, by a more subdued treatment, still retaining the "Butterfly" design.

Foreign and domestic examples of interior theater lighting were considered, and many things were found to be criticised in the lighting of the average theater, more especially the placing of light sources in the direct line of vision. The author devoted a considerable portion of his paper to a description of the recently installed lighting equipment of the Pabst Theater in Milwaukee. This is not a very large theater, but the lighting is notable because the indirect system is used throughout. The theater was built several years ago, so that the indirect lighting fixtures had to be adapted to existing conditions. The inverted-dome type is used largely and care had to be exercised in placing the fixtures in such a manner that the lamps inside of any of the fixtures could not be seen by the occupants of the highest row of seats in the gallery. Cove lighting is used in the foyer, supplemented in this particular part of the building by a little direct lighting. A large indirect-lighting fixture unit containing a number of lamps is hung from the center of the domed ceiling, 55 ft. from the floor. Above this are reflector disks utilizing an opening in the ceiling made at the time the original chandelier was placed in position.

As in other indirect lighting illumination, there is at first some impression of dimness in this theater, but after this has worn off, for it is more apparent than real, general satisfaction is expressed with the lighting, which is attended with less foot-candle intensity than with other systems. Mr. Vaughn spoke of another theater where it is planned to use the semi-indirect system of lighting throughout.

Exit lamps, so-called "panic" lamps, stairs, passage and fire-escape illumination all need careful attention. Working lamps for attendants are also provided in theaters, and in some cities there is a municipal requirement that there

shall be some dim lighting in the theater interior during dark periods. A gradation of intensity of lighting in different parts of the house is arranged in some cases.

Stage lighting, with its many accessories, combinations, spectacular effects, etc., forms a voluminous subject in itself. The switchboards now provided are elaborate and make possible a large number of different combinations. It is to be remarked that the introduction of tungsten lamps has brought about some new studies in the introduction of controlling resistance for dimmers in stage lighting. The performance of dimmers on alternating-current circuits supplying only tungsten lamps must be studied afresh. The manner of varying the intensity of light on the stage was touched upon by the speaker and also the different characteristics of the light from tungsten and carbon lamps. The interesting statement was made that any actor who "made up" in a dressing-room by the light of carbon lamps might present quite a different appearance when judged on the stage by the light of tungsten lamps.

Moving-picture machines, stereopticons, spot lighting, illuminated program announcers, dressing-room lighting and other features of theater lighting which must be taken into account by the illuminating engineer were touched upon briefly.

In the discussion Mr. J. R. Cravath said that the question of indirect lighting in theaters involves the question of detrimental effects of glare from light sources. He classified these effects under two separate headings. One of these is the reduction of ability to see clearly caused by glare in the field of vision. This seems to be closely akin to halation in photography, which tends to blur the plate when there is too much exposure of the latter to light sources. This effect is probably largely physiological. The other effect of glare is annoyance, or the distracting effect on the eye, which is largely psychological. The former effect has been investigated by Mr. A. J. Sweet, who was the first to make definite measurements of it.

Mr. A. J. Sweet emphasized his belief that discomfort as caused by glare and the effect of glare on clear vision or depression of visual function are two distinct phenomena. He expressed the belief that indirect lighting offers a more comfortable method of illumination than that commonly used and also that the absence of sharp shadows with indirect lighting is decidedly pleasing in its artistic effect. As to whether there is less depression of visual function by indirect lighting he expressed serious doubt. He thought that the annoyance and discomfort caused by glare are largely a matter of the intrinsic brilliancy of the source of light.

Mr. Cravath suggested that discomfort caused by glare is due not to the absolute intrinsic brilliancy, but to the intrinsic brilliancy of the light source compared to its surroundings. A certain lamp may be very annoying amid dark surroundings where it would be almost unnoticed amid much lighter surroundings.

The resignation of Mr. A. L. Eustice as secretary of the Chicago Section was announced. Mr. Eustice is about to leave the city to engage in business for himself.

"NIGHT IN NEW ORLEANS."

"Night in New Orleans" is the title of a souvenir booklet just issued by a local publisher, showing a collection of after-dark street scenes and panoramas in which the extensive electric lighting of the city appears to advantage. Besides many scenes in the modern business section, several views relate to the interesting old French quarter, where the background for modern electric illumination is furnished by such relics of the past as the old Hotel Royale, the historic Cabildo, the famous "haunted" home of an early slave-owner, and the house that was prepared for Napoleon in connection with an attempt to rescue him from St. Helena by New Orleans admirers.

NOTABLE INDIRECT ILLUMINATION OF A LARGE DINING-ROOM FROM FLOOR PEDESTALS.

An installation of indirect lighting really notable for its pleasing effect and comfortable quality has just been completed in the illumination scheme of the newly redecorated north café of the Congress Hotel, Chicago. This beautiful room, with its cream-colored walls and ceiling, done in the Louis XIV style, is lighted by reflection from a number of concealed high-power tungsten lamps carried in alabaster floor pedestals or vases, mounted above the plane of vision.

Entering the room without previous information, even the technical visitor fairly familiar with the tricks of the lighting art is likely to spend a puzzled moment searching out the source of the uniform, brilliant illumination with which the room is flooded. There are no visible lighting fixtures nor even the usual dark bowls of indirect reflectors to mar the unflecked ceiling. At a casual glance, the eight graceful, unobtrusive pedestal-vases among the tables on the floor appear to be only part of the elaborate decorative scheme of the room, and from no position do they give any direct evidence of the flux of light which they project on the ceiling. The whole room is thus bathed in a flood of

Indirect Lighting of Hotel Congress Dining-Room from Floor Pedestal Reflector.

brilliant illumination, uniformly distributed over the ceiling and walls, and the sense of relief that is gained by the absence of visible mechanical fixtures or trappings of any kind must be experienced to be appreciated.

The room itself measures 37 ft. by 95 ft., with a ceiling 20 ft. high, divided by 3-ft. beams into seven equal panels. In the walls, opposite each ceiling panel, are the recesses containing the tapestried windows and wall areas, the curtains being red, while all of the wall and ceiling surfaces are of cream white. The café is carpeted in a rich red with green figures, although the white cloths of the tables make up nearly a third of the lower light-receiving surface.

The lighting standards themselves are of a pure-white alabaster-like cement, molded in graceful designs with ornaments founded on the Greek and wreathed at their rims with garlands of flowers in colors. The tops of the bowls measure 8 ft. 6 in. above the floor and are 30 in. in internal diameter. Each contains four 400-watt tungsten units set vertically in individual "X-ray" reflectors. There are eight of these pedestals, aggregating 12,800 watts for the total indirect illumination of the room, which is equivalent to an expenditure of nearly 3.6 watts per square foot. The intensity of the lighting thus verges on the spectacular, and it is likely that its brilliancy will be decreased later. In arranging this unique installation, however, it was the pur-

pose of the architects, Messrs. Marshall & Fox, to provide at least ample illumination, and a large factor of safety was accordingly allowed in preparing the specifications from the original computations.

Ranged on the sixteen golden candelabra fixtures on the walls of the room are groups of ten frosted 25-watt tungsten lamps, each lamp being shielded from direct vision by an elliptical shade of red fabric. These direct-lighting fixtures are, however, not commonly used in the illumination of the room, for which the reflector units are relied upon entirely.

PORTABLE PLATFORM FOR CLEANING CHICAGO BOULEVARD LAMPS.

The last of the 165 ornamental tungsten standards which border both sides of Michigan Avenue, Chicago, from Randolph Street to Twelfth Street, has now been put into place, making this lake-front boulevard one of the best-lighted thoroughfares in the world, perhaps. As already mentioned in these columns, the cast-iron posts are of the unusual height of 19 ft. 6 in., carrying at their tops clusters of six 100-watt multiple tungsten lamps inclosed in 12-in. Alba globes.

On account of the unusual height of the posts and also the position of the lamps and globes on extended arms, an ordinary ladder cannot be used for cleaning the glassware or renewing lamps. The Board of South Park Commissioners accordingly had constructed the portable platform shown in the accompanying illustration. The structure is in the form of an equilateral tripod, measuring 8 ft. across at the base, and carries its 4-ft. circular platform at a distance of about 13 ft. above the sidewalk, bringing the lamps to about the height of a man's shoulder. The framework is of 1½-in. steel tubing, cross-braced with steel guy wires. One of the three legs of the tripod is made double and forms the ladder by which the platform is reached. Each leg is fitted with a 10-in. rubber-tired wheel, the leading wheel of the three being attached to a small tongue, by which the platform can be pulled along the sidewalk. To place the scaffold in position it is pushed up against the post, the 4-ft. platform completely inclosing the standard except for the 12-in. entry slot. The pole is also engaged by a similar slot in the lower part of the base, a pin being provided for closing this gap and so locking the structure in place before the platform is ascended. A box for tools and repair parts is also firmly attached to the steel framework of the platform. As the result of its construction of steel tubing, the complete platform is very light, weighing less than 300 lb., and can be easily pulled along the sidewalk and lifted over curbs by the cleaner.

Portable Platform Used for Cleaning Ornamental Lamps.

RECENT TELEPHONE PATENTS.

CIRCUIT SYSTEMS.

If lamp signals are to be used with the magneto-type system, the devices responsive to the magneto current must not only close the lamp circuit but they must be provided with some locking device which will cause the lamp circuit to be maintained until the proper response is made. It is with this kind of system that the patent granted to Mr. J. Erickson, of Chicago, is concerned. He provides a three-wire jack with a line and cut-off relay. The jack springs are normally disconnected from the line while the line relay is connected. When a current is generated by the subscriber station magneto the line relay responds and its armature becomes mechanically locked by a latch piece. The line lamp circuit is thus maintained until the operator responds. This energizes the cut-off relay, which in operating cuts off the line relay from the line and establishes the jack-spring connection. At the same time the latch is withdrawn, the line relay armature falls back and the line lamp circuit is broken. This patent is assigned to the Automatic Electric Company.

A patent granted to Mr. H. F. Joeckel, of Camp Point, Ill., describes a system in which more than one station is connected intermediate of the switchboards at either end. At one end the grounded drop is connected to one side of the line, while at the other end the grounded drop is attached to the second side. This is done to have as nearly as possible a balanced condition. The intermediate stations are bridged and are equipped with keys so that either metallic or suitably directed grounder currents may be generated.

NEW APPARATUS.

Mr. W. C. Moeller, of Doon, Ia., is the inventor of an extension-arm desk set of new design. The arm takes the form of lazy-tongs, while the transmitter support is a vertical tube expanded to a cylindrical box near the middle of its length. This box has its ends or flat sides vertical and the hook-switch lever projects through one flat face, the springs, pivot and wiring terminals being within.

The contour of the usual receiver cap is such that if this cap be made of sheet metal the space between it and the diaphragm will not be such as to produce good transmission. For the best effect a thin, flat air space must be provided in front of the diaphragm. This can be accomplished with the pressed-metal cap by mounting a flat circular piece within the cap. In the receiver casing recently patented by Mr. W. W. Dean and assigned to the Dean Electric Company this disk is made of insulating material and the edge of the sound orifice of the cap is drawn down to project through the disk. The latter is then finally secured by spinning the metal rim back over it.

LETTER TO THE EDITOR.

Loading of Telephone Circuits.

To the Editor of Electrical World:

SIR:—I have been exceedingly interested in reading Mr. Frank B. Jewett's letter appearing in your issue of Sept. 9, criticising my article on "The Loading of Telephone Cable

and Open-Wire Circuits" (July 15), as it tends to show what an erroneous impression may be formed by the superficial perusal of any article. To correct any erroneous conclusions to which his criticism of the article under discussion may give rise I wish briefly to discuss the points in the article to which Mr. Jewett takes exception.

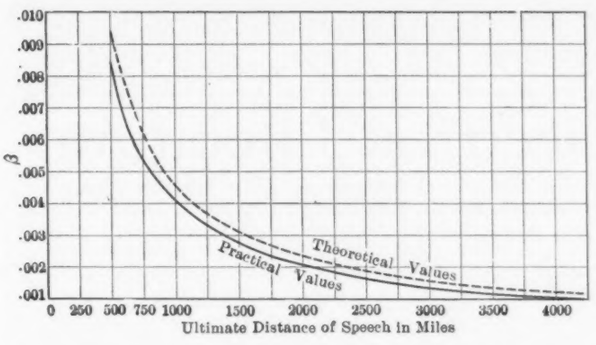


Fig. 1—Theoretical and Practical Values of β for Ultimate Speech Distance in Aerial Circuits.

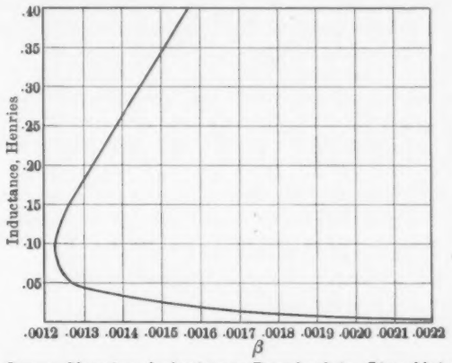


Fig. 2—Curve Showing Inductance Required to Give Values of β for No. 8 Circuit (3.95 Ohms for Loop-Mile).

He states that "a perusal of the article . . . indicates that the author appears to have an erroneous conception of the theory of neutralizing the effect of capacity in telephone circuits by the introduction of lumped inductance in accordance with the Pupin system," and goes on to state that "on page 167 the author computes the inductance necessary to neutralize completely the capacity of a circuit at 800 frequency. He does this as though the capacity and the inductance were simply lumped in a series circuit, and speaks of the impedance of the circuit as being equal to $[R^2 + (L\omega - 1/C\omega)^2]^{1/2}$."

"As is well known, this method of computing the line impedance does not apply to a circuit containing capacity and inductance distributed along its length in the manner of a loaded telephone circuit."

By referring to the article Mr. Jewett will see that I state, "to find the balancing inductance of any circuit, by treating the speech wave as a simple alternating current having a frequency of 800 cycles per second, etc." . . .

From this it will be seen that I am not dealing with a loaded circuit, and that the equation for the impedance stated above is correct for the case in which it is used, as I am treating the speech impulse as a simple alternating current of 800 cycles propagated along a circuit in which capacity and inductance are both present. The reason for treating the speech impulse in this way was to show in as simple a manner as possible why it was impossible to get a distortionless telephone circuit, even though loading by Pupin's system was adopted, and also to show why for any given amount of added inductance the relative improvement in transmission is much greater for a cable than for an open-wire circuit.

With regard to the next point to which exception is taken, namely, the working out of Example II, page 167, I must plead guilty to a typographical error, in which the figures 4 and 8 have been transposed, and the error carried through the rest of the working; but it is not, as stated by Mr. Jewett, "an arithmetical mistake . . .of simple proportion," as the equation is given correctly, the mistake being as stated above. I do not, however, consider this mistake of vital importance, as no attempt has been made, as Mr. Jewett seems to consider, "to explain the result by a process of reasoning which leads to the remarkable conclusion that although loading improves the articulation it reduces the volume of sound or amplitude." No process of reasoning whatever is based on the result, as it is merely used as an example illustrating how to determine the values of L and the distant end amplitude. The "remarkable conclusion" to which Mr. Jewett takes exception is based on the deduced result $L = (R + R_c)^2 C/4\beta$, or $\beta = (R + R_c)/2\,(C/L)^{1/2}$.

From this it will be seen that the value of β increases rapidly with R_c (the impedance of the loading coil), reducing the amplitude, proving, as stated, that "although loading improves the articulation (by reducing the distortion), it reduces the volume of the sound (by increasing the attenuation)." This is graphically illustrated by the βL curve (Fig. 2).

Continuing to the next point raised, by referring back to page 165, column 2, we have this sentence: "Attenuation in itself is not harmful if not carried too far, as a receiver will convey an intelligible conversation when the amplitude is reduced to 1 per cent (of the transmitting end amplitude) if there is no distortion of the wave form." This is the recognized absolute limit of transmission; therefore, when the transmitting end amplitude is reduced to 1 per cent the value of βd is 4.60511, or $e^{-\beta d} = 100$, which is the absolute limiting point at which loading is commercially of value. This explains the method used in arriving at the value of βd to six significant figures.

The last point raised is in regard to taking the practical value of βd to five significant figures after stating "this value has to be reduced *approximately* 10 per cent to allow for extraordinary losses . . . which *cannot be calculated.*"

As Mr. Jewett is aware, a curve cannot be plotted with an approximate value, so some definite value had to be assigned to βd to get Curve 2, Fig. 1. I took the value of these losses as exactly 10 per cent (which I considered a very fair estimate) in order to arrive at the points on the curve. By taking it to five significant figures it was obvious that this value of $\beta d = 4.1446$ was exactly 10 per cent less than that used in determining the value of Curve 1, and I thought that this method would save a lengthy explanation in the article, showing how this second value of βd was arrived at, which would have been necessary if I had only taken the result to, say, two significant figures.

Taking the letter as a whole, I fail to see from the points raised how Mr. Jewett substantiates his contention that the article indicates "that the author appears to have an erroneous conception of the theory of neutralizing the capacity in telephone circuits by the introduction of lumped inductance in accordance with the Pupin system," as the main points to which exceptions are taken can hardly be said to affect the theory of loading.

Mr. Frank F. Fowle, in his letter on the same article in your issue of Aug. 12, raises another point, namely, in regard to Fig. 2 (reproduced herewith) and states that "Fig. 2 does not appear to be derived from the expression for β in terms of R, L and C" (this figure shows that there is a loss of efficiency where loading above 0.1 henry per mile is adopted), and seems to base this conclusion on the fact that "* * * aerial lines have been loaded with coils having 0.25 henry each spaced 2 miles apart, or more than 0.1 henry per mile, and there is no observed loss of effi-

ciency by heavy loading." This is misleading, as Mr. Fowle does not state the loop resistance per mile of the circuit on which this loading was used. By referring to page 169 it will be seen that it is definitely stated that this figure (as well as Fig. 3) applies only to a circuit having a loop resistance per mile of 3.95 ohms strung under the stated conditions, and that for other circuits a similar curve should be plotted. A similar curve plotted for a circuit having a loop resistance per mile of 6.51 ohms shows that the critical point is not reached till 0.15 henry per mile has been added, showing that it is quite possible to have coils of 0.25 henry spaced 2 miles apart without a loss of efficiency being observed due to heavy loading.

Winnipeg, Man. SAMUEL R. PARKER.

Digest of Current Electrical Literature

ABSTRACTS OF THE IMPORTANT ARTICLES APPEARING IN THE ELECTRICAL PERIODICAL PRESS OF THE WORLD

Generators, Motors and Transformers.

Vibrating Rectifier.—The vibrating rectifier of Villard depends on the movement of a small plate actuated by the alternating current to be converted. It needs, however, readjusting when it is to be used for another frequency, as it can only be used for the frequency for which it is tuned. Later Soulier devised a rectifier based on the fact that the diaphragm of the telephone receiver accommodates itself to all the different frequencies of the human voice. Soulier thus devised a rectifier which would operate without previous adjustment on all ordinary frequencies. However, his rectifier made use of only one half-wave of the alternating current. The other half-wave was suppressed. Soulier has now invented a system of connections by which both half-waves can be utilized. The arrangement is shown in Fig. 1. Two vibrating diaphragms stretched between two points 1′ and 2′ respectively can vibrate like the diaphragm of a telephone receiver. Each of these is provided at the center with a contact piece which makes contact with the pieces 5 and 5′. A soft-iron core is magnetized by a coil 11 by means of a source of direct current (in the present case the storage battery *B*, which is to be charged from the alternating-current supply shown at the bottom of the diaphragm). At the two ends of the soft-iron core there are two other magnetizing coils 4 and 4′ supplied with the alternating current from the supply network. The electromagnet, which is polarized in this way, gives to the diaphragms a movement in synchronism with the alternating current. The diaphragms are in absolute synchronism even when the frequency changes, and the movements of the diaphragm are exactly in phase with the current wave, so that the closing and opening of the contacts occur always when the current wave passes through the zero point. For this reason the wear and tear of the contacts has been negligible in practice during five years.—*La Revue Elec.*, Oct. 27.

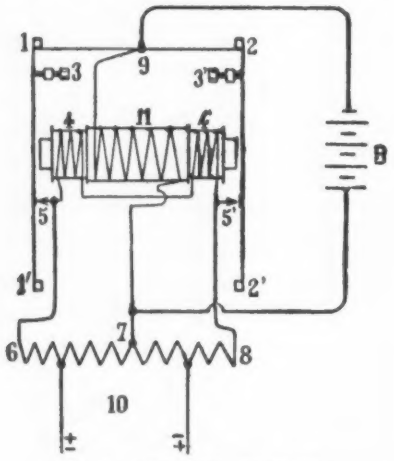


Fig. 1—Vibrating Rectifier.

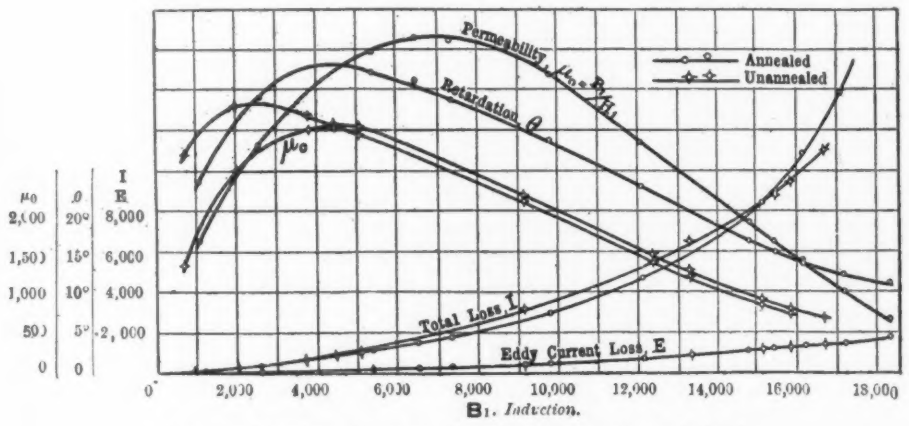


Fig. 2—Diagram Showing Magnetic Properties of Stalloy.

Magnetic Properties of Stalloy.—H. R. HAMLEY AND A. L. ROSSITER.—A paper read before the Royal Society of Victoria, giving an account of extended experiments on the magnetic properties of stalloy, a special alloy steel for use in transformers, employing both direct current and alternating current of different frequencies. Three different tests were made, namely, (1) statical tests; (2) tests on the effect of variation of frequency on magnetic hysteresis, and (3) tests on the effect of annealing upon each of the above. The usual statical experiments were made for inductions extending up to about 14,000. From these results were calculated the hysteresis losses and Steinmetz coefficients, using as exponent in the usual formula the value 1.6, which was found to be approximately correct for this substance. The alternating-current experiments were divided into three series, of "periods 0.07, 0.035, 0.02 respectively," probably corresponding to 14.3 cycles, 28.6 cycles and 50 cycles per second. At each of these the period and wave-form of the magnetic current were kept as nearly as possible constant as the magnetic density was increased. Stalloy in the unannealed state is magnetically unstable, but this is changed by annealing. The other chief results of annealing are to increase the permeability and to lower the hysteresis loss. The values of the permeability did not rise to nearly the values obtained by other observers. For unannealed stalloy the maximum is 2660 at a magnetic density of about 4000 lines per square centimeter, and in the annealed samples it rises to 3500 at a density of about 6000. Some of the results of the tests are given in Fig. 2, which show clearly the effect of annealing. The total loss *I* in the stalloy is a distinct improvement over that for iron. For all inductions and for all frequencies the total loss is found to be less for stalloy than for ordinary iron of the same thickness. A very fair impression of the stalloy total losses is obtained by taking two-thirds of the corresponding values for ordinary iron at all magnetic densities. Further, these losses are greatly reduced by annealing. This reduction is not very appreciable for densities below 5000, but above that there is a marked difference. However, the curves intersect where the density is 15,500; for higher densities the annealed losses increase very rapidly. From a practical point of

view Fig. 3 is perhaps the most interesting. In this figure the values of the total hysteresis and eddy-current losses are given for the annealed ring. These curves show an almost proportional increase of I and E with increase of frequency. That this should be so for E is evident, but on examination it is found that I is given approximately in terms of n and B for values of densities up to 11,000 by the Steinmetz analogue proposed by Lyle for iron—namely, for the annealed ring

$$I = (0.00106 + 0.0000226n)\, B^{1.88},$$

and for the unannealed ring

$$I = (0.00184 + 0.0000331n)\, B^{1.5}.$$

These forms agree fairly well with experiment, except in a few isolated cases occurring chiefly in the unannealed sample. The value of the exponent for each case is remarkable, for it seldom falls below 1.57 for iron. A fair average equation for transformer iron is found to be

$$I = (0.00175 + 0.000027n)\, B^{1.87}.$$

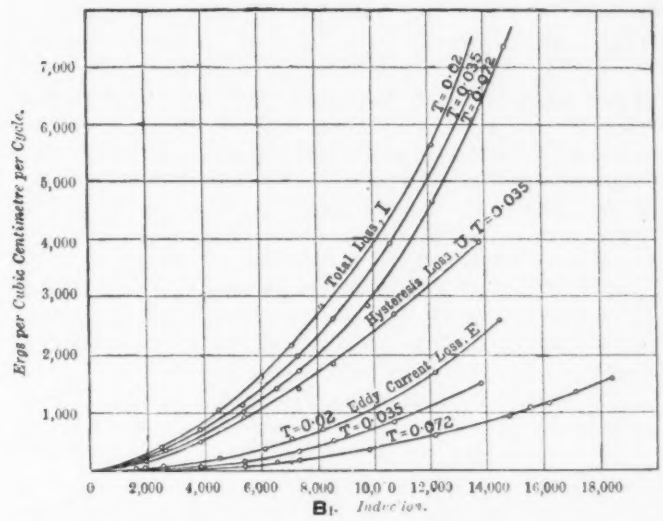


Fig. 3—Variation of Losses with Magnetic Density.

The value of the specific resistance was found to be slightly higher than that given by other experimenters, but 50,000 may be taken as a fair working value. These disks, which are much thicker than those actually used in iron-work, show an eddy-current loss much less than that calculated for iron of only half the thickness, the value being about one-quarter of the total loss. Seeing that for stalloy the total loss I is itself less than for iron, the former must be considered admirably suitable for transformer work. The values of the eddy-current loss E increase rather considerably with increase of frequency, the relative increase being greater than for I. This fact will be seen in the illustration, which gives all the losses to the same scale. Perhaps the most remarkable results are those obtained for the hysteresis loss U. The values for the middle frequency (0.035) only are plotted in the illustrations; but the values for the other frequencies practically coincide with those from which the graph is plotted. Results for ordinary iron show an increase of U with frequency which, although small, is still much greater than the maximum variation for stalloy which occurs between the periods 0.035 and 0.02. The values of U for periods 0.07 and 0.035 are practically identical. For stalloy, therefore, U seems to be independent of the frequency and only about half the magnitude of that obtained for ordinary iron.—Lond. *Electrician,* Nov. 3.

Three-Phase Commutator Machine.—R. MOSER.—A long theoretical paper illustrated by diagrams in which the author gives the theory of the three-phase commutator machine when running exactly in synchronism. The discussion is made under the following heads: Fundamental form of synchronous commutator machine; arrangement of brushes; load diagram; rotor current; brush current; copper losses and brush losses; brush voltage; comparison between direct-current excitation and synchronous polyphase excitation; commutation; effect of irregularity of the rotary field on commutation; effect of irregularity of the rotary field on the rotor voltage; the damping winding, and the load diagram taking account of the ohmic drop and the iron losses in the stator.—*Elek. u Masch.* (Vienna), Oct. 8 and 15.

Magnetic Losses in Dynamo Armatures.—G. VALLAURI.—The author first gives the theory of the magnetic losses in dynamo armatures without and with slots. He shows that it is advantageous to base the calculation of the magnetic armature losses on the figure of the mean tangential induction and then to apply a correction factor. After developing the theory the author gives results of tests of a special machine built for this purpose.—*Elek. u. Masch.* (Vienna), Oct. 1 and 8.

Current Diagram of the Three-Phase Series Motor.—A. THOMÄLEN.—Rüdenberg has shown how the performance of the three-phase series motor may be represented very simply by means of voltage diagrams. The author shows how by a simple change of scale the voltage diagram may be immediately transformed into a current diagram.—*Elek. Zeit.,* Nov. 2.

Lamps and Lighting.

Moore-Tube Lighting Installation.—G. HILPERT.—An illustrated description of a three-phase Moore-tube lighting installation in the lecture-room of the electrical laboratory of the Institute of Technology in Breslau in Germany. The tubes are arranged in star connection. The mean illumination of the lecture-room is 120.9 lux (hefner lumens per square meter) or about 10 ft.-candles. The illumination is very uniform, as may be seen from the fact that the ratio of the maximum lux to the minimum lux is 2.45. Such low values of this ratio are otherwise obtained only by purely indirect illumination. The specific consumption is 0.442 watt per lux per square meter, which agrees well with former measurements.—*Elek. Zeit.,* Nov. 2.

Metallic-Filament Lamp.—A note on a recent British patent (1544, Oct. 26) of the W. C. Heræus Company and C. Trenzen. A process of sintering partly decarbonized metallic filaments consists in placing them in a tube of pure iridium, which is heated to a temperature between 1400 deg. and 1600 deg. C. by passing currents up to 1500 amp through it in the presence of a reducing gas.—Lond. *Elec. Eng'ing,* Nov. 2.

Mercury Air-Pump.—S. R. WILLIAMS.—An illustrated description of a mercury pump constructed on the principle of the chain and bucket water-pump.—Lond. *Electrician.* Nov. 3.

Electrophysics and Magnetism.

Pressure of Radiation.—D. OWEN.—A review of our present knowledge of the subject under the following headings: Thermodynamics of radiation; interaction of ether and matter; astronomical applications of radiation pressure of sunlight.—Lond. *Electrician,* Nov. 3.

Poynting's Theorem.—J. F. H. DOUGLAS.—A simple elementary proof of Poynting's theorem on the flow of electrical energy through space.—*Phys. Review,* October.

Installations, Systems and Appliances.

Electric Heating and Cooking.—PH. STEUER.—The design of electric cooking and heating apparatus has been so improved as to give efficiency of 90 per cent or more. But the real problem is to devise a suitably low rate in order to make electric cooking and heating economical. The cost of generating electrical energy consists of the fixed cost (interest and amortization) and the variable cost of operation. In general 80 per cent of the total cost is fixed costs. Since progress in electric heating and cooking would not require an increase in the equipment of the central station, the author recommends that the rate for electric heating and cooking shall be so chosen that only the variable cost, not the fixed cost, shall be paid for. The author favors a

combination of flat rate and meter charge and proposes to make a distinction between the energy used for lighting, motor service and heating and cooking purposes. The present high price of electric heating and cooking apparatus is also a disadvantage, and it may be more economical to cheapen the apparatus even if they are less efficient. —*Elek. Zeit.*, Nov. 2.

Electricity in Aeronautics.—R. Chasseriaud.—While electric motors have been used on dirigible balloons, this is not the case with aeroplanes. The reason is that they have too great a weight, not so much the motor itself as the storage battery required. The author then discusses the use of auxiliary electric motors in connection with devices for the purpose of insuring stability of the aeroplane.—*La Lumière Elec.*, Oct. 28.

Units, Measurements and Instruments.

Pyrometers.—R. S. Whipple.—The author describes some improvements which he believes will add largely to the value of pyrometers in industrial work, both as to their suitability for particular processes and to the scientific accuracy of the results. They include Peake's patent compensating leads; cold junction control; Peake's scale-control box, and a thermocouple potentiometer.—Lond. *Electrician*, Nov. 3.

Telegraphy, Telephony and Signals.

A New Phonograph.—An illustrated description of a new sound-recording apparatus exhibited by the inventor, S.

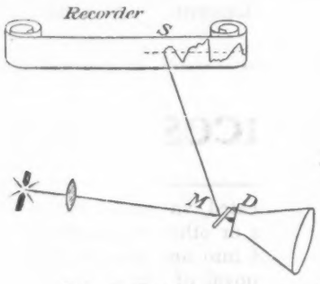


Fig. 4—Recorder.

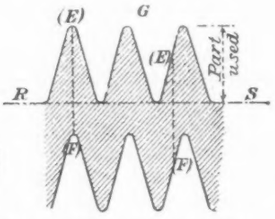


Fig. 5—Wave Made by Beam Having the Form of EF.

Lifschitz, at a recent meeting of the Academy of Sciences in Paris. The inventor uses a small mirror *M* (see Fig. 4) hinged so as to vibrate by the action of the telephone diaphragm *D*. A beam of light is thrown on the mirror from an arc lamp through a lens, and is reflected so as to give a spot *S* on the screen. A band of sensitized photographic paper is used and is driven between a pair of rollers by an electric motor so that the film travels very rapidly. In actual practice, however, Lifschitz uses a narrow band of light instead of a spot, as represented at *EF* (Fig. 5). When this band vibrates in the same way as the spot, with an up-and-down movement as the sensitive film passes

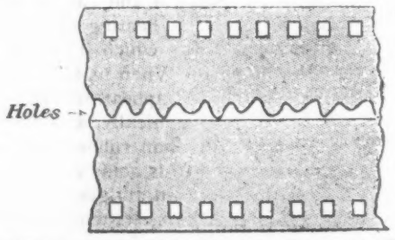


Fig. 6—Specimen of Record Band Holes Formed in Final Record Strip (Letter T, Long).

under it, a certain surface is covered by the light from the beam, as shown by the shaded portion *G*, and the form of this surface depends as before on the particular sound impressed on the diaphragm. By developing the film the part *G* can thus be produced in black upon a transparent film. A standard cinematograph film is used, as it is the most convenient. This is printed as a negative upon a second film of the same kind, the latter being formed of bichromated gelatine, so that by printing and washing in the well-known way the parts unacted upon by the light appear

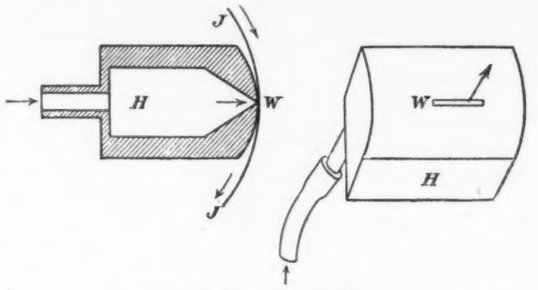
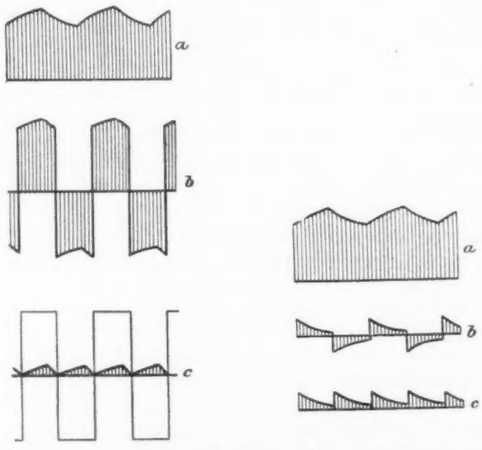


Fig. 7—Sound Reproducer.

on this second film as holes, thus producing a band as seen in Fig. 6, with the holes corresponding to the shape of the waves. It is not necessary to use the whole of the surface *G*, but only the part lying above the dotted line *RS* (Fig. 5). To produce the original sound from the present record a current of air passing through the openings in the band is employed. For this purpose the small air chamber *H* (Fig. 7) is used. This is fed with compressed air from any convenient source, such as a small storage tank or steel bottle. The film *JJ* is mounted between a pair of rollers which are driven by an electric motor so that it passes rapidly over the curved surface of the chamber. A narrow slit *W* allows the air to escape through the openings in the band, and the length of the slit is adjusted so that it corresponds to the maximum height of the openings; that is, to the highest point on the waves. The slit is therefore fully opened at such maximum points and entirely closed at the zero points. Between these limits the air delivery depends on the shape of the waves, and thus sounds are produced by the rapid succession of air emissions so obtained. These sounds correspond to those spoken into the mouthpiece, so that there is proper reproduction.—Lond. *Electrician*, Nov. 3.

Overcoming the Inertia of Selenium Cells for Transmission of Pictures.—Bohuslav Zavada.—It is well known that the rapid variations in the illumination of a selenium cell are well reproduced by corresponding variations of re-



Figs. 8 and 9—Curves Showing Current Established in a Selenium Cell by the Rapid Variation of Light.

sistance and current. For uses in which the absolute value of the current and its low changes are of no account the selenium cell is, therefore, well suited. For the transmission of pictures the author proposes not to use continuous illumination of the selenium cell as varied only by

the greater or smaller darkness of the different portions of the picture to be transmitted, but to use intermittent illumination and to place a commutator on the axle of the disk which interrupts the light. The effect is shown in Fig. 8, where *a* is the current in the selenium cell with intermittent illumination and *b* is the current after commutation. The curve *b* may be resolved into two curves, as shown in *c*. If in the receiving station a direct-current instrument is used, only the small variations (indicated in *c* by the shaded areas) have an influence on the instrument. Since there is no advantage in sending a large inactive current through the receiving instrument the endeavor should be to reduce it as much as possible. Several means for this purpose are described. One is to transform the current through the selenium cell by means of a transformer and to commutate only the secondary current, as is shown in Fig. 9, in which *a* is the current through the selenium cell with intermittent illumination, *b* is the current after transformation and *c* is the transformed current after commutation.—*Elek. Zeit.*, Nov. 2.

Wireless Telegraphy.—L. ZEHNDER.—The author discusses the question whether electromagnetic waves over the ocean (as used in wireless telegraphy) are propagated with the speed of propagation in air or with the speed of propagation in water. The author believes the latter is the case. He suggests an experiment by which this question could be settled. He further discusses the reason why in general the distances to which wireless messages may be transmitted are greater at night than during the day. He believes the reason has to do with the change of refraction coefficient of the atmosphere and the surface of the earth. He finally suggests a secret code for wireless telegrams which could not be deciphered by ordinary methods.—*Elek. Zeit.*, Nov. 2.

High-Speed Cable Telegraphy.—BELA GATI.—The author has formerly discussed the theory of high-speed telegraphy. Telegraph engineers have stated that with such high speeds as suggested by him the signs would run one into the other or overlap. However, the author maintains that this is the case only with direct-current telegraphy, and not with alternating-current telegraphy, and gives oscillograms to prove his point that the lengthening of the signs occurs only with direct-current telegraphy. He finally maintains that with ocean cables having a self-induction of 10^{-3} henry per kilometer high-speed telegraphy is certainly possible.—*Elek. u. Masch.* (Vienna), Oct. 15.

BOOK REVIEW.

DER EDISONAKKUMULATOR. By Meno Kammerhoff. Berlin: Julius Springer. 182 pages, 94 illus., 20 tables. Price, 4 marks.

An excellent practical treatise on the construction, characteristics, theory and cost of the Edison storage battery from the standpoint of the engineer and electric automobile maker or operator. Numerous tables of weights, sizes and outputs accompany the text and many arithmetical examples are given of applications for this excellent modern type of storage cell. The backwardness of electrotechnical book literature in English is illustrated by the appearance in the German language of this book, dealing with a distinctively American development. A translation in English is much to be desired.

New Apparatus and Appliances

LARGE HIGH-TENSION SUBMARINE CABLE.

The Habirshaw Wire Company has just completed a notable cable for the New York Edison Company, which will be laid in the Harlem River. The cable is in four lengths of 800 ft. each and consists of three thirty-seven-strand conductors, each of 350,000 circ. mils. Each conductor is insulated with a 13-64-in. wall of 30 per cent Para compound overlaid with tape. The three conductors are laid up in clover-leaf form with fillers consisting of tape, 11-64-in. rubber jacket of 30 per cent Para tape, ⅛-in. lead sheath, jute bedding, an armor of thirty-eight No. 4 galvanized-steel wires and covered finally with two layers of jute and tar. The cable is to be operated under 13,000 volts working pressure and was tested for 25,000 volts for one-half hour between conductors and conductors and ground. It is about 4 in. in diameter and the shipping weight of each length of 800 ft. is about 18,000 lb.

AN IMPROVED LOW-TENSION INSULATING COMPOUND.

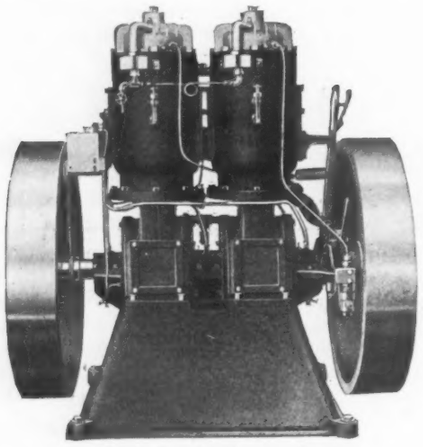
Based on its experience in producing insulating compounds of high grade for high-tension insulation, the Minerallac Electric Company, Chicago, has recently developed an improved insulation for low-tension use where voltages below 2000 volts are involved. This minerallac No. 20, as it is designated, has a dielectric strength of 700 volts per mil; a high melting point, 260 deg. Fahr.; a high flash point, 650 deg. Fahr., and a coefficient of specific inductive capacity of only 1.98, taking air as unity. It is declared to be absolutely non-hygroscopic, and to be free from impurities injurious to rubber, copper, paper, cloth or other material used in electrical construction. No disagreeable fumes are given off when it is heated, so that it can be used without objection in manholes or other closed places. The new compound can be molded into any desired form and retains its shape after the removal of the mold. On account of its freedom from absorbing water or occluding air bubbles, minerallac No. 20 can be relied upon to give a definite insulating strength for a given thickness, while its low specific inductive capacity is of particular advantage in telephone work.

AN IMPROVED MOLDED INSULATION.

Under the name of Stern-Condensite the Dickinson Manufacturing Company, Springfield, Mass., is introducing an improved molded insulating material, the invention of Mr. J. W. Aylsworth, for years research chemist of the Edison laboratories. Condensite is a phenol-formaldehyde product which is soluble in alcohol and can be used as a varnish or shellac. Upon simple heating the material is converted into the plastic form in which it can be molded easily, setting without air holes. When molded Stern-Condensite presents a highly finished appearance like polished black hard rubber, although mechanically, according to the manufacturer, it is far stronger than rubber. It possesses high dielectric resistance, withstands acids and weathering, does not break down under its own fatigue, is non-hygroscopic even when boiled in water, resists temperatures up to 350 deg. Fahr. without softening and can be molded into any shape, inclosing metal parts if desired. Stern-Condensite can be machined, tapped, drilled or sawed easily, and when molded leaves the mold in a finished state. It is odorless and tasteless, but is resilient, though lighter than hard rubber, with which it is declared to compare favorably in price.

INTERNAL COMBUSTION ENGINE.

The fuel-oil engine of the Remington Oil Engine Company, Stamford, Conn., involves a principle of vaporizing and igniting heavy oils which, it is claimed, is entirely new and unused by oil-engine builders. The company's engineer has devised a method of atomizing, vaporizing and burning fuel oil whereby the process of vaporization does not separate the heavy hydrocarbons of the oil into their constituent parts, thereby giving a deposit of carbon. Vaporization is effected without the "cracking" of the oil and



Two-Cylinder Stationary Engine.

with a clean exhaust. The irregularities of vaporization and ignition in oil engines have in the past made it necessary to construct excessively heavy machines in order to insure steady running and establish small limits of variation of angular speed. By this method of vaporizing and burning heavy oils a regularity of operation is said to be obtained which allows the engine to have only medium weight. The result is that the engine operates with excellent speed regulation from full load to no load and with no deposit of carbon in the cylinder even though operation be carried on for long periods at no load. This, the manufacturer claims, has never before been accomplished without the use of high pressure. The fuel consumption of the engine in sizes as small as 15 hp is stated to be not over 0.6 lb. of fuel oil per brake-hp. The consumption is less in the larger sizes, and, as fuel oil of a density from 25 deg. to 28 deg. Baumé has about 18,500 heat units per pound, it is apparent that the thermal efficiency of this type of engine is high even in the smaller units.

ELECTRIC SOLDERING TOOL.

The use of the ordinary soldering tool has two drawbacks—the impossibility of keeping it hot continuously and the rapid wasting away of the copper. The development of the electric soldering iron obviated the former, furnishing the mechanic not only with a tool which stayed uniformly hot all the time but also with one in which the heat intensity could be easily regulated by the mere turning on or off of the electricity. The second fault—that is, the rapid wasting away of the copper—still remained, to a large extent, necessitating frequent renewals, and consequently making no reduction in the cost of maintenance. As a result of many experiments made in the research laboratories of the General Electric Company to mitigate this fault, there has been developed a process of treating the copper which renders the latter non-oxidizable under high heats and non-corrodible by the acids used in soldering. Furthermore, it reduces to a minimum the dissolving action of the molten tin, with which the working tip must always be kept coated. It is claimed that this "calorizing" method of treatment does not merely coat the surface of the copper with a thin layer of non-oxidizable or non-corrodible substance, liable to scale off under the effects of heat and acids, but it actually changes the characteristics of the copper to an appreciable depth. Thus the durability or practical working life of the copper is increased to such an extent as to provide a soldering tool of maximum economy and effectiveness.

NEW CUTLER-HAMMER CANOPY SWITCHES.

In the first canopy switches made by the Cutler-Hammer Manufacturing Company, of Milwaukee, split porcelain bodies were used. Since then the company has developed a fireproof and waterproof insulating material which is used

Fig. 1—Canopy Switches.

for the bodies of new switches. This material, which can be molded with unusual accuracy, is tough and at the same time insures permanent alignment of the operating parts.

In the switch illustrated herewith, which is entirely new, the push button is replaced by a threaded stem. This switch has been developed to be installed in the bottom shell of ceiling fixtures. It is operated by pushing and pulling the bottom knob of the fixture as screwed on the

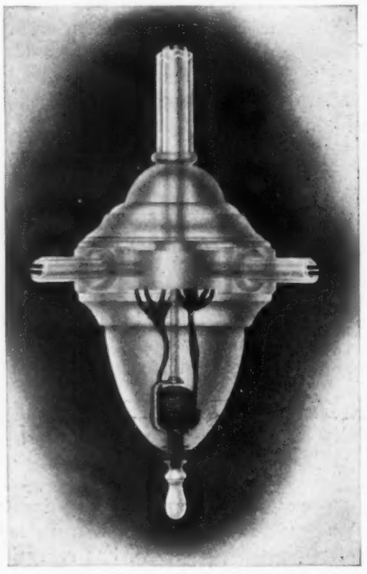


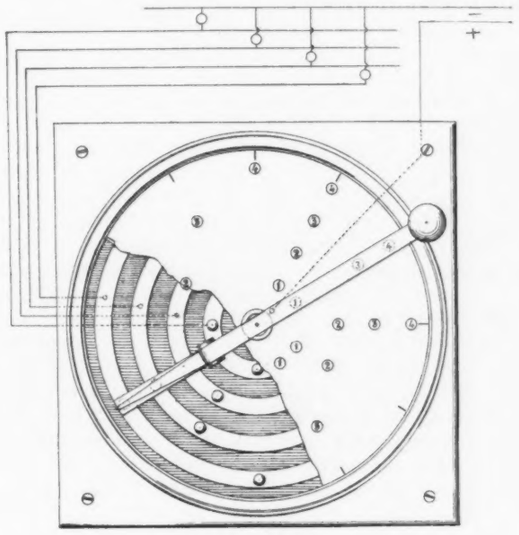
Fig. 2—Canopy Switch Installed in Bottom Shell of Ceiling Fixture.

threaded stem of the switch. The appearance of the fixture is unchanged and the necessity of wiring to a wall switch is eliminated.

In the large twelve-story Lowry Building, just finished in St. Paul, Minn., 1500 of these canopy switches were installed. All the wall brackets were provided in this manner and keyless sockets were used.

A RING-SWITCH FOR DOMESTIC LIGHTING CIRCUITS.

A new type of ring-switch has been devised by Mr. F. W. Kurtz, of Manhattan College, New York City, which permits the lighting of any group of lamps, or several groups, or all of them at the same time. This is effected, as shown



Ring-Switch.

in the accompanying illustration, by moving an arm over a series of studs inserted in a number of concentric copper rings which are themselves connected with the different lighting circuits. The device is handy and reliable in operation; it is simple in construction and saves a considerable amount of the wiring usually employed.

A SIMPLE SIGN FLASHER.

The motor-driven flasher shown in the illustration is intended for signs having few lamps or for window decorations and displays. The machine is compact and low-priced and is said to be more flexible and of larger range

Sign Flasher.

than the so-called automatic flashers. The worm shaft runs on roller bearings, and the outfit is provided with laminated brushes, which are adjustable. The flashers of the type illustrated constitute an entirely new line and are made in sizes ranging from 5 amp to 12 amp per switch, and they can be equipped with any number of switches. The machine is adapted for a number of purposes, as flashing first one side and then the other side of a sign, or flashing first the border and then the reading matter, or various color combinations, or spelling out a word letter by letter, etc. It is said by the manufacturer, the Reynolds Electric Flasher Manufacturing Company, of Chicago, to cost but little more than an ordinary fan motor.

ELECTRICAL BUSINESS MEN DISCUSS CREDITS.

About eighty representative electrical business men from Chicago, St. Louis, Cleveland, Minneapolis, St. Paul, Milwaukee, Detroit, Cincinnati and other cities of the Central West attended the sixteenth annual meeting of the Electrical Credit Association of Chicago, which was held at the Chicago Athletic Club on Nov. 16. Mr. A. O. Kuehmsted, of Chicago, vice-president, occupied the chair, as President Frank M. Pierce, of the same city, was unable to be present. Mr. Kuehmsted presented the president's annual report, and Mr. James Wolff, of Chicago, made a brief report as the official representative of the association in the National Electrical Credit Association. Mr. Frederic P. Vose, of Chicago, presented an interesting report as secretary-treasurer. He showed that the association has 211 company members and that the number of claims reported to the association in 1911 was 4389, representing an indebtedness to members of $355,357. The total number of claims settled during the year was 2398, amounting to $180,124. About 51 per cent in cash was collected of the total amount reported. The total amount collected since the establishment of the association in 1896 was $1,588,873. The estimated amount of claims settled during the life of the association in all forms is $3,093,757.

Greetings were presented from the Philadelphia and New York associations, and it was announced that in the future the annual meetings of the Chicago association would be held on the third Thursday in November. By a vote the national association was requested to withdraw what is known as "operative resolution No. 41," which relates to the guaranteeing of the accounts of delinquent debtors by third persons.

On the report of the nominating committee officers were elected as follows: President, Mr. S. E. Kennedy, Central Electric Company; vice-president, Mr. A. O. Kuehmsted, Gregory Electric Company; national representative, Mr. James Wolff, New York Insulated Wire Company; secretary-treasurer, Mr. Frederic P. Vose, Marquette Building, Chicago; executive committee (new members), Messrs. Charles E. Ummach, W. S. Edwards Manufacturing Company; William A. Browne, M. B. Austin & Company; R. M. McConnell, Westinghouse Electric & Manufacturing Company. A vote of thanks was extended to the retiring officers and members of the executive committee.

The greater part of the afternoon was devoted to the reading and discussion of papers. Mr. Kuehmsted was first with a paper on "Disputed Accounts and the Executive Committee," and he was followed by Mr. W. J. Burton, of the Frank Adam Electric Company, of St. Louis, who read a paper prepared by Mr. W. A. Brady on "Keeping Faith." This was followed by the paper of Mr. F. D. Van Winkle, of the Post-Glover Electric Company, of Cincinnati, on "Forms and Model Letters," after which Mr. Kennedy, the new president, read a paper entitled "Does the Association Pay?"

Mr. E. R. Gilmore, of the Western Electric Company, was next with a paper entitled "Contractors as Credit Risks." In the course of this paper the writer declared that the small electrical contractors are possibly the poorest risks in the electrical business. The remedy should be to exercise some discrimination and help the worthy ones as they start in business by educating them in bookkeeping and methods of doing business so that they may develop into well-rounded

business men. Mr. T. I. Stacey agreed with this, and Mr. W. E. Stephenson, of Minneapolis, remarked that perhaps 80 per cent of the "grief" of electrical credit men comes from the small contractor. He made the amusing statement that perhaps every electrical contractor in Minneapolis and St. Paul has an automobile while hardly one jobber can boast of such a luxury. Mr. Wolff, Mr. Frank Horton, of Chicago, and others took part in the discussion.

The discussion on reporting municipal delinquents was opened by Mr. Vose, and Mr. Stephenson and others participated in it. After some debate it was recommended to the national association that information should be distributed to the members of the association stating when municipalities are paying by warrant rather than in cash, but municipalities paying by warrant should not be described as delinquent debtors.

NEW ST. LOUIS-MADE ALTERNATING-CURRENT DEVICES.

At a meeting of the St. Louis League of Electrical Interests on Nov. 14 Mr. W. A. Layman, vice-president and general manager of the Wagner Electric Manufacturing Company, of that city, was to have addressed the society on "Some New Alternating-Current Apparatus Made in St. Louis." Mr. Layman was called out of town unexpectedly at the last moment, and his place was taken by Mr. F. N. Jewett, sales manager of the Wagner company, who spoke on the same subject.

The St. Louis League of Electrical Interests has shown its devotion to the interests of its city in several ways. For one thing it raised a fund sufficient to build and maintain electric signs advertising the city of St. Louis and placed them in five large Eastern cities. Believing that members of the league are interested in knowing what a representative electrical manufacturer of St. Louis is doing, and believing also that the advance in the electrical art has been so great that some people are prone to think that further progress is unlikely, Mr. Jewett pointed out that three new and original electrical devices have been produced in the home city within the last year. The speaker insisted that these devices are not merely improvements of hitherto existing types, although to outward appearance two of them might be so considered. On careful examination, however, it will be seen that each one of the appliances

Fig. 1—Single-Phase Converter.

is a real invention and a new contribution to the electrical art.

The three devices described are the Wagner alternating-current rectifier, the Wagner single-phase converter and the Wagner unity-power-factor single-phase motor. It was pointed out that the great number of automobile, motor-boat and other small gas and gasoline engines has developed a large field for small storage batteries to provide energy for ignition purposes. To provide a small, compact, portable rectifier for the many owners of such storage batteries in alternating-current sources of supply the Wagner company developed an ingenious and radically new device to suit the requirements. This rectifier consists essentially of a vibrating armature in connection with an electromagnet, the outfit including a small transformer and a resistance to limit the flow of charging current. The device has been described heretofore in this journal.

Mr. Jewett remarked on the fact that the mutual dependability of motor and storage battery has been so improved that the electric vehicle is now used to a much greater extent than ever before and is rapidly coming to the front in the automobile field. The Wagner company believes that it has discerned the need for a simple, compact and durable machine for converting alternating current into direct current for the charging of vehicle batteries, in addition to the various rectifying and converting appliances now available for this purpose. Therefore, it has brought out a single-phase converter which in a single unit is the mechanical equivalent of a motor-generator set operating on single-phase alternating-current supply and producing direct current. The machine possesses the outward characteristics of a standard single-phase motor, and, indeed, it may be used as a motor if desired. The speaker described the machine in detail and said that it should be useful for domestic purposes as at once affording a means of charging vehicle batteries and driving small machinery such as is frequently used about the household or in a private garage.

In conclusion Mr. Jewett spoke of the importance of the maintenance of high power-factor by central-station companies in selling and distributing alternating current. This brought him to the new unity-power-factor motor made by the Wagner company, which has been described heretofore in these columns. The talk was followed by an interesting discussion, the speaker of the day answering a number of questions.

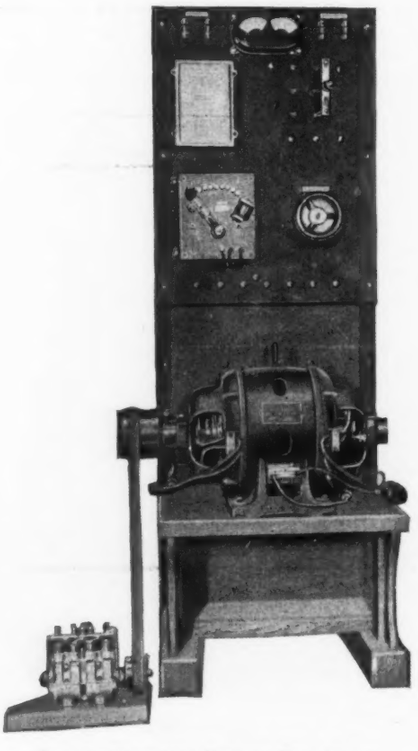


Fig. 2—Converter Driving Tire Pump.

Industrial and Commercial News

THE WEEK IN TRADE.

GAINS made in recent weeks, although moderate in volume, have served to bolster up the business outlook and impart to it a more cheerful view. Market sentiment was undoubtedly favorably affected by the position which Mr. Roosevelt took with respect to the government's suit against the Steel Corporation, and because of this and various other reasons improvement in prices prevailed. A larger volume of business is noticeable in the West, with further buying for the future. The seasonable weather and the approach of the holidays are imparting activity to the retail trade. The October exports were greater in value than those of any other October in the history of the export trade and the imports show an increase over those of the corresponding month of last year. An active demand for foundry and pig iron or low grade is reported to be developing in the East. The tonnage of steel rails placed for shipment this winter or as specified during 1912 during the past few weeks now totals about 175,000 tons, and actually pending inquiries total approximately 150,000 tons. Car builders are operating to greater capacity at present than at any other time during the year, and a shortage of cars threatens the West due to business improvements and to run-down equipment. The cotton-ginning figures issued by the Census Bureau Tuesday were in a measure disappointing, but showed by far the largest number of bales ever ginned up to Nov. 14. It is expected that this year's crop will reach 14,000,000 bales. Business failures for the week ending Nov. 16 as reported by *Bradst eet's* were 238, as compared with 237 last week, 248 in the corresponding week of 1910, 232 in 1909, 273 in 1908, and 265 in 1907.

THE COPPER MARKET.

THE price of copper continues to advance both here and abroad. Sales of electrolytic were reported on Tuesday as high as 13 cents a pound, and this continues to be the minimum quotation of the leading selling agency. The demand according to the producers continues to be good, exports showing up better than domestic shipments. Domestic consumers are not clamoring for copper, the consumption of the metal in this country being less than usual, and the prices are advancing under speculative influences. Consequently buying has been said to be in excess of melting requirements and several million pounds more of January and December electrolytic contracts were placed Nov. 21. European business as well as American business trade was mainly in December and January shipments. Estimates place the country's increase in new copper next year between 200,000,000 lb. and 250,000,000 lb. The first half of November showed a decline of 5,352,000 lb. in visible and 4,121,600 lb. in foreign stocks, leaving the world's visible stocks not greater than 268,000,000 lb. There is a suspicion, however, that copper in both refined and crude form is undergoing accumulation. The total exports from New York since Nov. 1 and including Nov. 21 aggregate 21,331 tons, which compares with 21,904 tons cleared in October for the principal North Atlantic ports. At the present rate exports for November will be around 65,000,000 lb., the greatest since last August. The daily call on the Metal Exchange Nov. 21 quoted copper as per the accompanying table.

Standard Copper.	Bid.	Asked.	Settling Price.
Spot	12.45	12.75	.....
November	12.50	12.75	12.62½
December	12.50	12.80	12.65
January	12.55	12.85	12.67½

The London market, November 21, was as follows:

	Noon. £ s d	Closing. £ s d
Standard copper, spot	57 8 9	57 13 9
Standard copper, futures	58 2 6	58 8 9

Extreme fluctuations for this year:

	Highest.	Lowest.
Standard	12.60c	11.57½c
London, spot	£57 13 9	£53 7 6
London, futures	58 10 0	54 0 0
Best selected	61 15 0	57 5 0

INDUSTRIAL AND COMMERCIAL NOTES.

Westinghouse, Church, Kerr & Company's Engagements.—Engineering work being carried on at present under direction of Westinghouse, Church, Kerr & Company includes the design and construction of a 2000-kw steam turbo-generator plant for the Harmony Mills at Cohoes, N. Y. This work includes the design and construction of the power-house building and stack, the installation of boilers, coal-handling equipment, electric-light and power wiring and switchboard, the construction of a bridge for heating and electric-transmission service between the power house and mills, together with the design and construction of a 2800-hp modern horizontal turbine water-power plant arranged for rope transmission to various parts of the mills and the design and installation of plumbing and other service facilities. Contracts have been placed for all material required for the above, and for the twenty-four-stall round-house, machine shop, storeroom, oil storage-room, power house and office building which the Westinghouse company is constructing at Champaign, Ill., for the Illinois Central Railroad. The power house will accommodate four 150-hp boilers, three of which are being installed at the present time; one 1000-cu. ft. air compressor and boiler-washing equipment, eight motor-driven deep-well pumps, three cinder pits, one inspection pit, a green-sand storage bin and sand-dryer house and equipment, lighting, heating and service equipment for the above-mentioned buildings, yard lighting, power wiring, yard-trench system, sanitary sewer and septic tank, one 1000-gal. water tank, two locomotive water columns and complete system of fire protection in yards and buildings. The work also includes the design and installation of service piping between the power house and various other buildings and the erection and equipment of a transformer house. Electric current is furnished by the local electric-light company. Space has been left in the power house for the future installation of generating units when desired.

Kansas City Telephone Service Restored in Ninety-eight Hours After Fire.—When the Missouri & Kansas Telephone Company's Fairmount Exchange at Kansas City, Mo., was completely destroyed, on Sunday, Oct. 22, at 3 a. m., by a fire which is believed to have been caused by an explosion of gas in the house adjoining that in which the central office was located, the telephone company at once communicated with the Western Electric Company, and the work of restoring service to the subscribers was begun at 9 o'clock on the same morning, when a dozen men from the electric company's local installing force appeared upon the scene. The Hawthorne factory of the Western Electric Company was called upon by long-distance telephone to make an emergency shipment, and responded by sending forward the necessary apparatus by express the evening of the day on which the fire occurred, thus supplementing without delay the work which was being done by the local house in rushing material to the building in which the new exchange was to be housed. The new switchboard equipment consisted of several sections from the telephone company's stock, and some from an addition which was to be installed at the Rosedale Exchange, on account of the increasing business in that district. Twenty-six installers reported for work on Monday morning, Oct. 23, and from that time until the new board was cut into service at 5 a. m. Oct. 26, with a full equipment of 800 subscribers' lines, day and night crews were at work continuously. Taking into consideration the fact that the work was done under high-speed conditions, in order that the subscribers might not be inconvenienced for an extended period, it is worthy of note that the trouble reports issued as a matter of routine by the telephone company indicate that the work of the Western Electric Company's installing force was so well done that a minimum of trouble was experienced after the new equipment was cut into service.

Hoskins Manufacturing Company Absorbs International Electric Meter Company.—The Hoskins Manufacturing Company, of Detroit, maker of the "Hoskins" electric furnaces, pyrometers and heating appliances, has purchased the business of the International Electric Meter Company, of Chi-

cago. The manufacture of the "International" instruments will be continued by the Hoskins company at its Detroit plant, with the same production organization that during the past seven years has made the "International" a line of established merit. The "International" measuring instruments comprise ammeters and voltmeters of portable and switchboard types in a variety of designs for alternating-current and direct-current circuits.

Block-Signal Practice.—The Ft. Dodge, Des Moines & Southern Railroad, which operates about 125 miles of track extending northward from Des Moines, Ia., to Ft. Dodge and Rockwell City, has contracted with the General Railway Signal Company, of Rochester, N. Y., to install continuous-track automatic block-signal protection on 18½ miles of track. This road formerly was operated by steam and now is operated by 1200-volt overhead trolley. Passenger cars are run in single units and freight trains are hauled by 40-ton electric locomotives, the ruling grades permitting handling a 1600-ton train with a two-unit locomotive. The block-signal installation is novel in that, while it conforms strictly to the automatic block-signal practice of steam railroads so far as circuits, relays and minor apparatus are concerned, the day as well as night indications will be given by lamp signals rather than semaphores. Each signal post will carry at its top a cast-iron box containing one red and one green lens, each 8½ in. in diameter. The lenses will be illuminated by 80-watt tantalum lamps placed in front of parabolic reflectors. By this means the intensity of illumination is sufficient to give an arrestive daylight signal indication at distances between 1500 ft. and 2000 ft.

New York Edison Company Seeks Review of Long Acre Case.—The New York Edison Company obtained a writ of certiorari from Supreme Court Justice Seabury Nov. 21 to review the determination of the Public Service Commission of the First District of New York, which grants the Long Acre Electric Light & Power Company permission to issue $10,000,000 of preferred stock and $50,000,000 of bonds. The petition states that the Edison company has invested millions in its plant and equipment, and has furnished electricity at reasonable rates, whereas the Long Acre company has a franchise which has never been operated according to law, has a floating indebtedness of $275,000, and property worth only $20,000, against which it has issued bonds of $1,000,000 to pay for its franchise. The petition states, moreover, that there is no public necessity for a competing company, and insists that the State of New York has adopted a policy of regulated monopoly in place of competition and that the New York Edison Company cannot be subjected to competition, but has a right to demand that it be protected against competition under the law as now interpreted.

Remy Electric Company.—The Remy Electric Company, of Anderson, Ind., manufacturer of magneto ignition and lighting devices for all types of gas engines and gasoline-motor-driven vehicles, which recently absorbed the American Electric Headlight Company and now makes the American electric headlight for steam locomotives, has purchased outright all patents, designs, good-will and manufacturing rights of the Peters electric headlight for steam locomotives. The locomotive headlight departments of the R. G. Peters Company, of Grand Rapids, Mich., have been moved to Anderson, and the Peters light will be owned, manufactured and sold by the Remy Company. New buildings will be erected at the Anderson plant to care for the increased production of the Peters lighting apparatus. The Remy company has taken over the leading men employed by the Peters company in its headlight department, and this addition to the corps of inventors and electric-headlight engineers puts the Remy company foremost in the development and perfection of the art of locomotive electric headlight designing and manufacturing.

Rebuilding of the Northern Ohio Traction & Light Company.—Due to the increasing load on the existing plant, and a desire to centralize the power generation, with its attendant economies, the Northern Ohio Traction & Light Company has decided to renew completely the electrical equipment of the greater portion of its system. It is the intention to install a new steam turbine and hydroelectric generating station at a point north of Akron, and to distribute energy from this station to substations located at Bedford, Town Line, Kent, South Akron, Barberton, Springfield Lake and New Berlin. The generating equipment will comprise three 60-cycle, three-phase, 7000-kva turbo-generators, two 150-kw turbo-generator exciters, nine 1100-kva oil-insulated, water-cooled transformers, one 20-kw motor-generator set, three 55-kva transformers, one main switchboard and the outgoing lines. The substations will contain the necessary step-down transformers and rotaries, the latter aggregating 6500 kw. The contract for the entire electrical equipment has been awarded to the Westinghouse Electric & Manufacturing Company.

Hydroelectric Development in Pachuca, Mexico.—The Pachuca Railway Company, which is constructing an electric railway from Pachucha to the Real del Monte mining district, will soon have the line finished. It will be about 12 miles long and in some respects is an interesting and unique piece of engineering work, owing to the rough character of the country. The company has adopted plans for extensive enlargement of its hydroelectric plant and service. It is already furnishing 1500 hp of electrical energy for mines and industries, and this is to be brought up to about 7500 hp. It has applied for concessions from the government for the construction of three large dams which will afford a water-storage capacity sufficient to generate the additional power that is required. Transmission lines will be constructed to the different mines and outlying industrial plants. The headquarters of the company are at Tepeji del Rio, in the Tula district of Pachuca. It is expected that the introduction of cheap electric power into the mining camps will greatly stimulate development operations of the mines.

Third Avenue Reorganization Plan Wins.—The litigation between the Public Service Commission of the First District, New York, and the Third Avenue Railroad Company was ended Nov. 21, when the Court of Appeals reversed the decision of the Public Service Commission and declared the reorganization plan legal. The decision is of moment, as upon it depends not only the reorganization of the Third Avenue Railroad, but also that of the Metropolitan Street Railway Company, a plan for the reorganization of which will be presented in the near future. It is expected that the Public Service Commission will ask the next Legislature to grant additional power so it will have jurisdiction in reorganization matters. It is doubtful, however, if this law can be effected in time to interfere with the reorganization of the entire street railway system of New York.

Bell Interests Acquire the Cumberland Telephone & Telegraph Company.—The American Telephone & Telegraph Company has accepted the offer made by the president of the Cumberland Telephone & Telegraph Company to sell to the former all of the latter's stock in the latter company at 160 and accrued dividends in bonds of the Cumberland Telephone & Telegraph Company. The bonds will become a mortgage on the property for twenty-five years at 5 per cent taken at par, with the option of taking American Telephone & Telegraph Company stock par for par if preferred. The bonds will be dated Jan. 1, 1912, and the total issue will not exceed $15,000,000. They will be subject only to a prior mortgage securing bonds now outstanding amounting to $750,000.

Reorganization of Milwaukee Electric Railway & Light Company.—The active management of the Milwaukee Electric Railway & Light Company has been placed in the hands of three department heads, so as to relieve Manager J. D. Mortimer of much detail work. The three heads are Messrs. R. B. Stearns, S. B. Way and R. N. Duffy. The first is in charge of the railway department, the second in charge of the light and power department, and the last will have supervision of the accounting, purchasing and stores, printing and advertising and publicity departments. Mr. Egbert Douglas has resigned as commercial engineer and has been made sales manager, and Mr. T. D. Crocker, general superintendent of the Milwaukee Central Heating Company, has been appointed commercial engineer.

Kelvin Engineering Company.—The Kelvin Engineering Company, 78 Wall Street, New York, has been incorporated for the purpose of doing a general engineering and contracting business, to make plans, specifications and estimates, to investigate and report, and to supervise and manage railway, industrial and electric plants. Its technical staff will be headed by Messrs. G. Lobo and J. H. Shearer, both engineers of professional training and long experience.

Electric Mules for Panama Canal.—The General Electric Company was the lowest bidder for the forty electric mules for pulling ships through the Panama Canal. These locomotives were described in a recent issue. The total contract aggregates about $500,000.

Financial.

THE WEEK IN WALL STREET.

THE conditions in Wall Street cannot be said to be assuming a cheerful aspect, for sharp contractions accompanied by recessions in prices marked the opening of the exchanges on Monday; and although stocks rose a trifle on Tuesday, trading reached its lowest ebb since Oct. 26. The market remained firm, however, in the face of inactivity. The decision of the Court of Appeals reversing the Public Service Commission on every point of its objections to the reorganization plans of the Third Avenue Railroad created a favorable impression in the financial district, although the stock dropped; the bonds, on the other hand, advanced in price. The announcement of increased earning by Brooklyn utilities was offset by the raise in rates from 5 cents to 7 cents announced by the Hudson & Manhattan Railroad on the subway leading uptown. On the whole, the recovery from last week's decline failed to develop a sufficiently broad demand for stocks to offer any effective offset to such pressure as the market encountered. From Friday of last week to Monday approximately $11,000,000 in gold was withdrawn from the banks, but the outflow did not introduce any unsettling factor. Such surface indications as rising prices in copper and increased exports are supposed to have contributed to the betterment which the market afterward experienced. The bond market apparently is in good shape and attracting investors, for an issue of over $10,000,000 offered by one banking house on a public utility Monday was taken up before the market closed on Tuesday. The money market experienced little change. Rates Nov. 21 were: Call, 2⅜ @ 2½ per cent; ninety days, 3¼ @ 3½ per cent. The quotations in the tables are those at the close of Nov. 21.

NEW YORK.

	Nov. 14.	Nov. 21.	Shares Sold.		Nov. 14.	Nov. 21.	Shares Sold.
All. Ch.....	3½	3¼	2,50	Int. Met., pf.	44	47⅜	11,050
All. Ch., pf..	13¼	13¼*	600	Mackay Cos..	85½*	85½*	200
Amal. Cop...	58⅞	64	89,300	Mackay C.,pf.	73⅜	73	100
Am. D. T....	33⅛*	33⅛*	———	Man. Elev...135		136*	310
Am. Loco....	35	36	1,600	Met. St. Ry.	15*	15*	———
Am. Loco., pf.103¾*		103¾*	100	N.Y.&N.J.Tel.139½*		139½*	———
Am. Tel. & C.	78*	78*	———	Steel, com...	62⅛	63¾	1,110,650
Am. T. & T..139		140	11,270	Steel, pfd....109¼		109⅛	8,130
B. R. T.....	78¼	78⅛	26,580	W. U. T....	77¼	78½*	2,300
Gen. Elec....153		155¾	2,100	West'h, com.	66	66	3,200
Int. Met.....	14½	15½	8,700	West'h, pfd..115*		115*	———

PHILADELPHIA.

	Nov. 14.	Nov. 21.		Nov. 14.	Nov. 21.
Am. Rys.....	45	45¾	Phila. R. T.....	23	23½
El. Co. of A.....	12	11⅞	Phila. Elec.....	16⅛	16
Elec. St. Bt'y.....	53½*	53½*	Phila. Trac.....	84½*	84½
Elec. St. Bt'y, pf...	30*	30*	Union Trac.....	51¾	51¾

CHICAGO.

	Nov. 14.	Nov. 21.		Nov. 14.	Nov. 21.
Chi. City Ry.....186*		186*	Com. Edison.....132½		133½
Chi. Elev. Rys.....	30	30*	Chi. Subway.....	¼	⅜
Chi. Elev. Rys., pf..	93	94*	Chi. Telephone.....123*		130¼
Chi. Rs., Ser. 1....	96*	95*	Nat'l Car.....105*		105*
Chi. Rs., Ser. 2....	33	33*	Nat'l Car, pfd.....118*		118*

BOSTON.

	Nov. 14.	Nov. 21.		Nov. 14.	Nov. 21.
Am. T. & T.....138¾		140	Mex. Tel.....	3*	3*
Cum. Tel.....152		155	Mex. Tel., pf.....	6½*	6½*
Edison 291		290	N. E. Tel.....148⅛		150
Gen. Elec.....153½		155½	W. T. & T.....	27½*	27½*
Mass. E. Ry.....	21	21⅞	W. T. & T., pf....107¼*		107¼*
Mass. E. Ry., pf....	93¾	95½			

*Last price quoted.
Shares sold for the week Nov. 13 to Nov. 18.

FINANCIAL NOTES.

Ironwood & Bessemer Railway & Light Company's Bonds Offer.—New York and Boston bankers are offering $1,344,400 first-mortgage 5 per cent sinking-fund gold bonds of the Ironwood & Bessemer Railway & Light Company, which is a consolidation of the Ashland Power Company, Ashland, Wis., and the Gogebic & Iron Counties Railway & Light Company, of Ironwood, Mich. The Ashland Power Company, through ownership of the majority of the stock of the Ashland Light, Power & Street Railway Company, of Ashland (1007 of 2000 shares), gives the Ironwood & Bessemer Railway & Light Company control of the electric-light, power, street-railway and gas business of the city of Ashland. The Gogebic & Iron Counties Railway & Light Company, through ownership of all of the bonds and stock of the Twin City General Electric Company, of Ironwood, and through ownership of all of the stock of the Gogebic Electric Company and the Gogebic Street Railway Company, of Bessemer, Mich. (these companies have no bonds), gives the Ironwood & Bessemer Railway & Light Company control of the electric-light, power and street-railway business in and between the two cities, serving a population of over 20,000 in one of the largest iron-ore-producing communities in the United States. The capitalization of the Ironwood & Bessemer company consists of an authorized issue of $2,500,000 first-mortgage 5 per cent sinking-fund gold bonds, with $1,344,400 issued; $200,000 6 per cent preferred stock, all of which has been issued, and $500,000 common stock, all of which has also been issued. The bonds which are offered for sale are dated Feb. 1, 1911, and are due Feb. 1, 1936. The price is 93½ and accrued interest, to net 5½ per cent per year. The bonds are secured by a first mortgage on all of the property of the Ironwood & Bessemer Railway & Light Company in the State of Wisconsin and by a first mortgage on all of the property of the company in the State of Michigan, through ownership of all of the bonds and stock of the Gogebic & Iron Counties Railway & Light Company, of Michigan, as mentioned above, which are deposited with the American Trust Company of Boston and held as security for the bonds of the Ironwood & Bessemer Railway & Light Company. The amount of bonds issued and outstanding is absolutely controlled by the Board of Railroad Commissioners of the State of Wisconsin, and new bonds may be issued with its permission for 75 per cent of the cash cost of new property, but only when the net earnings of the previous full year equal one and one-half times the interest charges on all of the bonds then outstanding and to be issued. The statement of earnings of the consolidated companies for the year ended Dec. 31, 1910, showed net earnings of $153,895, interest charges, assuming all bonds authorized are outstanding at the end of the year July 31, 1912, of $67,220, and a surplus of $86,675 available for dividends at the rate of 6 per cent on the preferred stock. These amounted to $12,000, leaving a surplus of $74,675 available for the common stock, which represents 14 per cent on that issue. The officials of the Ironwood & Bessemer Company estimate that in the year ending July 31, 1912, on the most conservative basis, the net earnings of the company will exceed $175,000, at which time the extensions and additions being made by the company will be completed.

Earnings of Public-Utility Companies Show Improvement.—The following public-utility companies showed increases in gross and net incomes for the month of September: Detroit United Railways, $66,023 and $10,822; United Railroads of San Francisco, $17,460 and $8,175; Northern Ohio Traction & Light Company, $21,133 and $10,158; Fairmont & Clarksburg Traction Company, $12,721 and $6,809; American Cities Company, $62,423 and $25,270; Cumberland Telephone & Telegraph Company, $51,153 and $9,457; Sao Paulo Tramway, Light & Power Company, $51,911 and $33,040; Rio de Janeiro Tramway, Light & Power Company, $135,902 and $86,635; Toronto Railway Company, $39,234 and $25,715; Dallas Electric Corporation, $11,445 and $3,682. The Keystone Telephone Company showed an increase in gross income of $3,232 and a decrease of $749 in net. The Mexican Tramways Company showed a decrease of $63,368 in gross and $32,701 in net. The Mexican Light & Power Company showed a decrease of $92,028 in gross and $37,314 in net. These large decreases shown by the Mexican companies are attributed to the unsettled conditions prevailing in the past months in the territories in which these companies operate.

Niagara, Lockport & Ontario Company's Earnings.—The report of the Niagara, Lockport & Ontario Power Company, Buffalo, N. Y., for the nine months ended Sept. 30 shows substantial increases in gross and net earnings as compared with those in the corresponding period of 1910. The returns from the sale of power were $800,742, as compared with $745,494, and the cost of power was $390,442, as compared with $362,430. Deduction of these expense items left balances of $410,300 and $383,064 in the periods ended Sept. 30, 1911, and Sept. 30, 1910, respectively. Operating expenses were $132,647, as compared with $134,541, and the amortization was $20,608, as compared with $15,826. The net earnings in the period ended Sept. 30, 1911, were $257,045, and other receipts were $17,197, making a total net income of $274,242, which compares with $245,068 in the corresponding nine months of 1910. The interest on first-mortgage bonds amounted to $187,500, leaving a balance of $86,742, which compares with $57,568 in the nine months ended Sept. 30, 1910, or an increase of 50.68 per cent.

Toronto Power Company to Spend Millions for Enlargements.—At a meeting of the board of directors of the Toronto Power Company presided over by Sir William MacKenzie last Saturday in Toronto, Ont., it was tentatively decided to expend approximately $3,000,000 on the system. The generating station at Niagara Falls, Ont., will be enlarged and machines installed to utilize the maximum amount of water allotted to the company by the treaty. This means that in addition to the three 8500-kw units now being installed four more will be added, making eleven in all. The completed project will then be capable of developing 125,000 electrical horse-power. In addition to the duplicate transmission line between Niagara Falls, Ont., and Toronto it is purposed to install another transmission line designed for an 85,000-volt circuit. The other line which now transmits at 60,000 volts will probably be modified to suit the higher potential. The plant and system of the Toronto Electric Light Company will be thoroughly overhauled and placed in excellent shape. Incident to these changes there has been a reorganization of the personnel of the companies, details of which have not yet become available. It is understood that the engineering work will be in charge of Mr. L. J. Hirt, who is associated with Dr. F. S. Pearson, of New York. Much of the energy will be required by the new railways projected by the MacKenzie interests in Ontario.

Kansas City Railway & Light Company's Year.—The report of the Kansas City Railway & Light Company for the year ended May 31 shows gross earnings of $7,727,680, which represents an increase of $566,639 over those of the previous year. Operating expenses and maintenance amounted to $4,450,535, an increase of $297,286, and the net income from operations was $3,277,145, an increase of $269,353 for the year. Other income amounted to $45,492, an increase of $28,094, making total net earnings of $3,322,637, or $297,446 more than those in the year ended May 31, 1910. Total charges amounted to $2,398,889, an increase of $240,928, and were made up as follows: Taxes, $585,864; interest on bonded debt, $1,475,434; bond discounts and commissions, $236,391; reserve for doubtful accounts, $30,425; interest on floating debt, $15,760; miscellaneous charges, $15, and bond sinking fund, $55,000. Deductions of charges left a net income of $923,748 available for preferred dividends, which amounted to $352,782 and were $117,594 less than those of the previous year. The surplus was $570,966, which was an increase of $174,112 over the surplus for the previous year.

Montreal Tramways.—New York, Boston and Chicago banking houses offered $10,445,000 first and refunding 5 per cent gold bonds of the Montreal Tramways Company, dated July 1, 1911, and due July 1, 1941. The company was organized under the special charter granted by the Province of Quebec, and has acquired the property rights and franchises of the Montreal Street Railway Company, and either the property rights and franchises or the entire capitalization of its affiliated companies, thus owning and controlling the street railway system of the metropolis of the Dominion. The bonds are secured by a first mortgage on a portion of the property, including the company's new power station, and on the remainder of the property subject to the underlying bonds, which mature in 1922. The proceeds of the bonds will be used as part payment for the properties acquired, the acquisition of which properties was authorized by the Quebec Public Utilities Commission. The bonds were all sold the day after the announcement.

Susquehanna Railway, Light & Power Company's Report.—The annual report of the Susquehanna Railway, Light & Power Company, of New York, which owns the entire common stock of the United Gas & Electric Company, the Lancaster County Railway & Light Company, and which controls the Wilkes-Barre Company, for the twelve months ended Sept. 30, 1911, shows a surplus of $383,073. Its subsidiary company, the United Gas & Electric Company, owns and controls the Colorado Springs (Col.) Light, Heat & Power Company, the Elmira (N. Y.) Water, Light & Railroad Company, the Lockport (N. Y.) Light, Heat & Power Company, the Leavenworth (Kan.) Light, Heat & Power Company, the Richmond (Ind.) Light, Heat & Power Company and a number of gas companies. The surplus is equivalent to 5 per cent of the $4,198,000 outstanding common, and an additional 2 per cent on the combined common and preferred stocks.

Iowa-Nebraska Public Service Company.—Bankers in Chicago are offering for sale at par first-mortgage, 6 per cent gold bonds of the Iowa-Nebraska Public Service Company to the amount of $350,000. This company owns and operates central stations in Missouri Valley, Ia., and Beatrice and Norfolk, Neb. It furnishes twenty-four-hour electric service in these cities and also transmits energy to neighboring communities. The authorized capital stock is $1,250,000, of which $775,000 is outstanding. The total issue of bonds is limited to $1,000,000, of which $650,000 is held by a trustee under restrictions, leaving $350,000 of outstanding bonds. The most recent report shows the annual revenue to be $122,987.85 gross, and $51,866.94 net after deducting taxes and other expenses.

Oil and Gas Merger in Arkansas.—H. M. Byllesby & Company, Chicago, have consolidated the General Pipe Line Company, the Ft. Smith & Little Rock Gas & Oil Company and the Arkansas Territorial Oil & Gas Company, whose combined capital approximates $2,000,000, with the General Southwestern Gas Company, a local Ft. Smith concern with a paid-up capital of $5,000,000. The General Southwestern Gas Company filed a $5,000,000 mortgage on Nov. 21, the proceeds of which will be used to prospect for oil and gas in Oklahoma and Arkansas.

Kings County Electric Company's Statement.—The report of the Kings County Electric Light & Power Company, Brooklyn, for the month of October shows gross earnings of $411,685, as against $355,238, and a surplus, after charges and depreciation, of $83,516, as against $69,736. The gross earnings for the year ended Oct. 30 showed an increase of $353,476 over the corresponding period of 1910.

Rio de Janeiro Tramway, Light & Power Company Stock Sold.—Advices from Montreal state that the Rio de Janeiro Tramway, Light & Power Company has sold $5,000,000 new stock to a London syndicate at 105. It is further stated that the stock will be offered to shareholders first at the same price, and such stock as is not taken up will be turned over to the London syndicate.

Detroit Edison's Stock Increase Ratified.—Stockholders of the Detroit Edison Company have ratified the proposal, mentioned in these columns Nov. 4, to increase the capital stock of the company from $9,000,000 to $15,000,000.

DIVIDENDS.

Chicago Elevated Railways, quarterly, preferred, 1½ per cent, payable Dec. 1.

Cities Service Company, monthly, preferred, one-half of 1 per cent; common, one-quarter of 1 per cent, both payable Dec. 1.

General Electric Company, quarterly, 2 per cent, payable Jan. 15.

Laclede Gas Company, quarterly, common, 1¾ per cent, preferred, 2½ per cent, payable Dec. 15.

Norfolk Railway & Light Company, semi-annual, 2½ per cent, payable Dec. 8.

Northern Ohio Traction & Light Company, quarterly, preferred 1¼ per cent, payable Jan. 2.

Philadelphia Electric Company, quarterly, 1½ per cent, payable Dec. 15.

Rochester Railway & Light Company, quarterly, preferred, 1¼ per cent, payable Dec. 1.

REPORTS OF EARNINGS.

Period	Gross Earnings.	Operating Expenses.	Net Earnings.	Fixed Charges.	Net Surplus.
CAPE BRETON ELECTRIC COMPANY, LTD.					
Sept., 1911.....	$30,314	$14,454	$15,859	$5,034	$10,825
Sept., 1910.....	28,835	13,112	15,722	5,006	10,715
EDISON ELECTRIC ILLUMINATING COMPANY OF BROCKTON, MASS.					
Sept., 1911.....	$30,102	$18,444	$11,658	$4,118	$7,540
Sept., 1910.....	25,701	14,582	11,119	4,241	6,877
HOUGHTON COUNTY (MICH.) ELECTRIC LIGHT COMPANY.					
Sept., 1911.....	$22,806	$9,085	$12,977	$5,622	$7,354
Sept., 1910.....	21,558	9,820	11,069	3,928	7,140
JACKSONVILLE (FLA.) TRACTION COMPANY.					
Sept., 1911.....	$45,098	$24,052	$21,046	$11,345	$9,700
Sept., 1910.....	45,994	27,156	18,838	8,408	10,429
LOWELL (MASS.) ELECTRIC LIGHT CORPORATION.					
Sept., 1911.....	$31,007	$16,770	$14,236	$4,425	$9,811
Sept., 1910.....	34,302	19,868	14,434	4,274	10,160
MINNEAPOLIS GENERAL ELECTRIC COMPANY.					
Sept., 1911.....	$127,157	$46,129	$81,028	$36,633	$44,395
Sept., 1910.....	115,901	39,781	76,119	32,350	43,768
PADUCAH (KY.) TRACTION & LIGHT COMPANY.					
Sept., 1911.....	$22,801	$12,133	$10,667	$7,166	$3,501
Sept., 1910.....	21,251	11,263	9,987	7,026	2,961
PENSACOLA (FLA.) ELECTRIC COMPANY.					
Sept., 1911.....	$24,667	$14,148	$10,519	$5,862	$4,656
Sept., 1910.....	23,264	13,959	9,305	5,206	4,098
WHATCOM COUNTY (WASH.) RAILWAY & LIGHT COMPANY.					
Sept., 1911.....	$32,911	$16,998	$15,913	$9,530	$6,383
Sept., 1910.....	33,781	17,331	16,449	9,083	7,366

General News

Construction News.

ELBERTA, ALA.—It is reported that the installation of an electric-light plant in Elberta is under consideration. Elberta has not a post office.

EUFAULA, ALA.—The City Council has awarded contracts for the construction, equipment and distributing system of the new municipal electric-light plant, to cost approximately $25,229.

PIEDMONT, ALA.—The contract for construction of the proposed municipal electric-light plant is reported to have been awarded to the J. B. McCrary Company, of Atlanta, Ga.

RAGLAND, ALA.—Preparations are being made by the Ragland Water Power Company for raising its dam and the construction of a water-power plant on the Coosa River at Lock No. 4, plans and specifications for which are being prepared by Martin H. Lide, of Birmingham, Ala. Contracts will be awarded as soon as plans are ready and bids received.

TALLADEGA, ALA.—The Alabama Power & Light Company, it is reported, has acquired the necessary property and is making arrangements for the construction of its proposed hydroelectric power plant at Jackson Shoals, near Talladega. The company expects to develop from 2000 to 3000 hp. Electricity generated at the plant will be transmitted to Talladega and Anniston. The cost of the plant is estimated at about $200,000. R. A. Mitchell, of Gadsden, Ala., is president of the company.

TUSCALOOSA, ALA.—The City Commissioners, it is reported, have granted a franchise to F. G. Blair and Henry B. Foster to construct and operate an electric plant, gas works and an electric railway in Tuscaloosa.

PARKER, ARIZ.—Plans are being considered by the New State Construction Company for the erection of a telephone system with a central exchange at Parker. The cost of the system is estimated at $10,000. W. H. Tharpe is general manager.

PHŒNIX, ARIZ.—The Salt River Valley Electric Railway Company has been granted a franchise by the City Council to construct and operate an electric railway in Phœnix for a period of twenty-five years. The proposed railway will be 65 miles in length and will connect Phœnix, Scottsdale, Tempe, Mesa, Chandler, Alhambra, Glendale and Peoria.

SAFFORD, ARIZ.—The Gila Valley Electric, Gas & Water Company is laying a water-distributing system in Safford and will pipe the supply from Mount Graham, which has a latitude of 11,500 ft. and is situated about 12 miles from Safford.

TUCSON, ARIZ.—The Federal Power & Water Company has filed notice of appropriation of 10,000 cu. ft. of water in Sabino Canyon and 5000 cu. ft. in Bear Canyon. Plans are being considered by the company for the construction of a dam near the junction of the canyons for impounding 5,000,000 cu. ft. of water and for the erection of a hydroelectric power plant at that point. H. W. Roche is president of the company and C. H. Ross secretary.

WICKENBURG, ARIZ.—The Big Blue Mining Company, operating on the Hassayampa River, is preparing plans for the erection of a hydroelectric power plant. The company proposes to supply electricity for its mines and other mining properties in this section. Robert H. Browne is in charge of the work.

JONESBORO, ARK.—The Jonesboro & Nettleton Interurban Railway Company has awarded a contract to Hemingway & Company for the construction of its proposed railway between Jonesboro and Nettleton, a distance of 5 miles.

ALAMEDA, CAL.—Bids will be received by F. E. Browning, clerk of the Council, until Dec. 5 for the erection of iron-pipe lamp-posts, conduits and wiring on Ninth Street from Pacific Avenue to Bay, Weber Street from Central Avenue to Bay, and Caroline Street from Santa Avenue to Bay, in accordance with plans and specifications on file in the office of the clerk.

BAKERSFIELD, CAL.—The San Joaquin Light & Power Company, it is reported, is planning to double-track its street railway system in Bakersfield.

DORRIS, CAL.—The Board of Trustees has granted the Siskiyou Electric Light & Power Company a franchise to erect and maintain transmission lines for the distribution of electricity in the town of Dorris.

EL CENTRO, CAL.—Plans are being considered by the Imperial Valley Telephone Company for the erection of a telephone line from El Centro to Seeley, via Imperial and Dixie. New stations will be established.

FRESNO, CAL.—The Board of Supervisors of Fresno County has granted the Pacific Light & Power Company, of Los Angeles, Cal., a fifty-year franchise to erect and maintain electric transmission lines from the east bank of the San Joaquin River to the Sierra National Forest Reserve, and to other points in the county, for which the company paid $100. The company will erect a transmission line from its proposed Big Creek power plant to Los Angeles, a distance of about 275 miles, the cost of which is estimated at about $10,000,000.

M'KITTRICK, CAL.—The Kern River Oil Company is installing new electric pumping machinery at its works.

NORDHOFF, CAL.—A movement is under way for the installation of an electric-light plant in Nordhoff by S. S. Beaman. It is proposed to enlarge the isolated electric plant, owned by H. H. Cockley, if sufficient patronage is guaranteed to justify the expenditure.

OAKDALE, CAL.—Plans are being considered by the Sierra Power Company for the installation of a new street-lighting system in Oakdale.

OROVILLE, CAL.—A petition is being circulated by the Monday Club to enforce an ordinance for placing all wires underground in the business district of the city.

OROVILLE, CAL.—Plans have been completed by the Oro Electric Company for beginning active construction work at Humbug early in the spring. One of the first developments will be on Yellow Creek. The company proposes to assemble the water in a 1700-acre storage reservoir in Yellow Creek Valley, from which point it will be dropped by means of pipe lines to the mouth of Yellow Creek on the north fork of Feather River, where the power house will be located.

OXNARD, CAL.—The installation of a municipal electric-light plant in Oxnard is under consideration by the City Trustees.

PLANADA, CAL.—The San Joaquin Light & Power Company is planning to install a distributing system in Planada. The company has completed its transmission line from Madera to Firebaugh, Dos Palos, Los Banos and Gustine, and has also installed distributing system in these places. The line will carry 30,000 volts and will be put into service Nov. 25.

POMONA, CAL.—The Southern California Edison Company contemplates rebuilding the street-lighting system in Pomona. It is proposed to erect twenty-six arc lamps in the business district and to furnish an all-night service. The present incandescent street-lighting system will be replaced with tungsten lamps. A mercury-arc rectifier will be installed in the substation on Second Street, to provide for the service in the downtown district.

PORTOLA, CAL.—The Reno Mill & Lumber Company, which recently secured the water rights and franchises of the Portola Light & Power Company, is planning to construct a dam on Grizzly Creek to furnish power to generate electricity in the town of Portola. The cost of the proposed plant is estimated at $40,000.

SACRAMENTO, CAL.—Preparations are being made by the Sacramento Electric, Gas & Railway Company for the erection of a new building at Eleventh and K Streets, bids for which are being asked.

SAN BERNARDINO, CAL.—The Southern Sierras Power Company has awarded the contract for the erection of its transmission line from San Bernardino to Riverside, a distance of 70 miles, to M. D. French, Grosse Building, Los Angeles, Cal., at $159 per mile.

SAN DIEGO, CAL.—The San Diego Electric Railroad Company is contemplating the installation of a steam-heating system in San Diego. The company will soon apply to the City Council for a franchise to lay steam pipes on certain streets for distribution of same.

SAN FRANCISCO, CAL.—The Forestry Department has rejected the application of the Nevada-California Canal & Power Company for a right-of-way across the public domain in Mono County.

SAN FRANCISCO, CAL.—Plans are being prepared by the engineering department of the City Electric Company for the erection of a substation which is to be locatd on Folsom Street east of Sixth Street, to cost approximately $10,000.

SAN FRANCISCO, CAL.—The contract for electrical and steam work in the new hotel building to be erected on Mission and Seventh Streets by Josephine Dupuy has been awarded to the John G. Sutton Company, of San Francisco, Cal., at $6,450.

SAN JOSE, CAL.—The Board of Supervisors has accepted the bid of the Great Western Power Company for a franchise to erect a transmission line in this county. The price paid for the franchise was $110.

SAN RAFAEL, CAL.—Sealed bids will be received by Robert E. Graham, clerk of Board of Supervisors, until Dec. 3 for the installation and maintenance of a complete electric street-lighting system in the Corte-Madera lighting district.

SELMA, CAL.—Plans are being made by the Pacific Telephone & Telegraph Company for extensions and improvements to its local system, including the installation of an underground conduit system in the business district. A. Terkell is district commercial agent.

STOCKTON, CAL.—At an election held Nov. 14 the proposition for the installation of a municipal underground electrolier street-lighting system was carried.

STOCKTON, CAL.—Preparations are being made for the installation of a new steam turbine and generator in the power plant at the county hospital, for which bids have been called for. Eugene D. Graham is clerk.

TOCALOMA, CAL.—Plans are being considered for extensive improvements to the Tocaloma Hotel, recently purchased by Anthony Tosy, which will involve an expenditure of about $10,000 and include the construction of a large concrete dam on the river and installation of a waterwheel and generator to supply electricity for the hotel and ranch, owned by Mr. Codoni.

VISALIA, CAL.—The Board of County Supervisors has awarded the Tulare County Power Company a franchise to erect transmission lines in certain sections of Tulare County for the transmission and distribution of electricity. The price paid for the franchise was $100.

BOULDER, COL.—The power plant and mill of the A. K. R. Gold Mining Company, located near Boulder, were recently destroyed by fire. It is understood that the plants will be rebuilt.

GEORGETOWN, COL.—The Boston-Idaho Electrical Company has erected a transmission line from Idaho Springs to Georgetown. It is understood that the company proposes to supply electricity in this city, for which application will soon be made to the City Council. The Boston-Idaho Electrical Company controls four plants in Clear Creek County, two of which are located at Idaho Springs, one at Alice and one at Georgetown. The latter was recently purchased from the Two American Sisters Mining Company. W. E. Renshaw, of Idaho Springs, is manager.

LONGMONT, COL.—A temporary injunction restraining the city of Longmont from proceeding with the construction of the municipal electric-light plant authorized by the voters at the election in April, 1911, has been issued by Judge Harry P. Gamble of the District Court on the application of the Northern Colorado Power Company, which has begun suit to secure a permanent injunction against the city building a municipal lighting plant.

PUEBLO, COL.—The Pueblo & Suburban Traction & Lighting Company has purchased a site at the intersection of Union Avenue and Main Street, on which it proposes to build a new office building.

SUGAR CITY, COL.—The Ordway Electric Light & Power Company, of Ordway, Col., which operates the local electric plant, announces that a twenty-four-hour service will be established beginning Jan. 1, 1912. Orders have been placed for new equipment.

WALSENBURG, COL.—Arrangements are being made by the Trinidad Electric Transmission, Gas & Railway Company, of Trinidad, for the construction of another power plant near Walsenburg. About 4000 kw will be developed, which will be supplied to mines in this vicinity.

TAKOMA PARK, D. C.—No bids were submitted for lighting the streets of Takoma Park, Md., the electric lighting companies claiming that a two-year contract is too short to justify the outlay for installation of the system. The installation of a municipal lighting plant is now under consideration. The bids called for 100 electric lamps of at least 40 cp. Benjamin G. Davis, 110 Oak Avenue, Takoma Park, D. C., is clerk and treasurer.

WASHINGTON, D. C.—The Bureau of Manufactures is in receipt of a communication from a business man in India stating that he desires to purchase from American manufacturers dynamos, motors, oil engines and machinery, and would like to receive as soon as possible catalogues and full particulars from such manufacturers. For further information address No. 7594, Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C.

WASHINGTON, D. C.—The American vice consul-general at Santo Domingo has forwarded a translation of the basis for specifications calling for bids for the installation of a new electric-light plant to supply electricity for lighting the city of Santo Domingo, Dominican Republic, bids for which will be received until Dec. 15. The specifications call for a privately owned plant, the present municipal plant being inadequate and unsatisfactory. Proposals are to be addressed to the office of the secretary. Copy of notice and translation can be obtained on application to the Bureau of Manufacturing, No. 7596, Department of Commerce and Labor, Washington, D. C.

FORT BARRANCAS, FLA.—It is reported that A. M. Lockett & Co., of New Orleans, La., has secured the contract for furnishing pump and other work in connection with the power plant at Fort Barrancas, Fla.

MADISON, FLA.—The City Council has accepted the proposition of the Madison Electric Power Company to sell its plant to the town, subject to the approval of the voters. An election will soon be called to submit the proposition to vote of the people.

ATLANTA, GA.—The Appalachian Power Company has filed amendments to its charter changing its name to the Appalachian Electric Power Company. Investigations are now being made by the company of its five properties in North Georgia to determine on plans for developments. The company proposes to supply energy in Toccoa, Ga., and Walhalla, Seneca and Westminster, S. C. A franchise has already been granted the company in Toccoa.

ROME, GA.—The Chattanooga Traction Company has applied for a franchise to construct and operate an electric railway in Rome.

HONOLULU, HAWAII.—The Island Investment Company has awarded a contract to the Von Hamm-Young Company for the hydro-electric plant which it is building between Wailuku and Kahului on Maui, for the purpose of supplying electricity for lamps and motors to these towns. The equipment is for the steam-power plant and California oil will be used for fuel.

CALDWELL, IDAHO.—The Idaho-Oregon Light & Power Company, of Boise, Idaho, has applied to the Council for a franchise to construct and operate an electric railway over certain streets in the city.

BOISE, IDAHO.—The Long Valley Light & Power Company, recently organized, it is said, proposes to supply electricity to six cities in west central Idaho.

HORSE SHOE BEND, IDAHO.—Plans are being prepared by the Pacific Power & Light Company for the installation of an electric-light system at Horseshoe Bend to the Wahkiacus Heights district. The company will extend its transmission line from its power plant on the little Klickitat River, a distance of about 5 miles.

SALMON, IDAHO.—The Lemhi Telephone Company is contemplating the erection of a telephone line along the Lemhi River, 60 miles in length. W. A. McCutcheon is president of the company.

ALTON, ILL.—The Madison County Light & Power Company has secured a franchise to supply electricity for lighting the villages of East Alton and Woodriver. It is understood that the company will soon apply to the City Council of Alton for a franchise to operate in this city. The power house of the company is located in Venice, Ill.

ALTON, ILL.—Frank L. Butler, receiver for the Alton, Jacksonville & Peoria Interurban Railway Company, has filed a report with the Madison County Circuit Court at Edwardsville in which he recommends that the plan for the railway to generate electricity be abandoned, and that a 300-kw rotary converter be purchased and installed in a substation, which would be erected at a point 16 miles north of Alton, at a cost of about $6,000. It is proposed to purchase electrical energy to operate the railway from the Alton Gas & Electric Company.

ARCOLA, ILL.—Orders have recently been placed by the Arcola Electric Light Company for a new engine and generator, to cost $5,500, preparatory to establishing a twenty-four-hour service. The company is negotiating with the City Council of Arthur to furnish electricity for lighting the streets of the city. The company offers to supply forty street lamps at $1,000 per year. If this proposition is accepted a transmission line will be erected to Arthur, which would probably be extended to Chesterville. The erection of a transmission line to Hindsboro is also under consideration.

CHICAGO, ILL.—The Public Service Company of Northern Illinois has increased its capital stock from $1,000 to $25,000.

CHICAGO, ILL.—The capital stock of the West Hammond Gas & Electric Company has been increased from $5,000 to $15,000.

CHICAGO, ILL.—Application has been made to the City Council by the Chicago City Railway Company for a franchise to double-track and extend several of its lines in Chicago.

CHICAGO, ILL.—Plans are being considered by the Dearborn Street Improvement Association for erecting ornamental lamps on Dearborn Street between Polk and East Lake Streets, which will involve an expenditure of about $50,000. It is proposed to erect standards similar to those on Michigan Avenue in the downtown district.

DECATUR, ILL.—The contract for excavation work for main building and power plant at the Decatur and Macon County Hospital has been awarded to Cope & McDonald.

FRANKFORT, ILL.—It is reported that plans are being considered for organizing an electric-light company in Frankfort by the local business men.

GEORGETOWN, ILL.—The Georgetown Electric Light Company has applied to the City Council for a ten-year extension to its franchise. The company was originally granted a twelve-year franchise seven years ago. The city is considering the question of changing the arc-lamp street-lighting system for tungsten lamps. Under the present contract the city has thirty arc lamps, for which it pays $75 each per year.

LITCHFIELD, ILL.—Bids will be received by the city clerk of Litchfield, Ill., until Dec. 18 for lighting the streets of the city. The specifications call for eighty-five lamps to burn all night. The contract with the local company expires Jan. 1, 1912.

MANHATTAN, ILL.—The Economy Light & Power Company, of Joliet, Ill., is extending its transmission lines to Manhattan to supply electricity for lighting the town.

MOKENA, ILL.—The Economy Light & Power Company, of Joliet, Ill., is negotiating with the village officials for a franchise to supply electricity in Mokena and a contract for lighting the streets of the village. The company asks for a fifty-year franchise and a ten-year contract for street lighting. It is estimated that twenty-two three-unit cluster lamps and fifteen single street lamps will be required to light the streets. It is proposed to erect a transmission line from Joliet to Mokena.

PEORIA, ILL.—Orders have been placed by the Illinois Traction System with the General Electric Company, of Schenectady, N. Y., for one 750-600-volt rotary converter, three H-25-kw transformers and a switchboard for its Bondsville station.

PEORIA, ILL.—Preliminary steps have been taken by the Peoria Gas & Electric Company to extend its service to Eureka, Roanoke and Metamora, Ill. The company has secured a contract to supply power to the Eureka plant. The company will extend its transmission line

from Washington. The cost of the proposed extension is estimated at $15,000.

QUINCY, ILL.—The light committee of the City Council is asking for bids for the installation of eighteen ornamental lamp standards and lamps to be installed in and around Washington Square.

RUSHVILLE, ILL.—Sealed proposals will be received at the office of the city clerk, Rushville, Ill., until Dec. 4 for furnishing material and labor for improvements to the municipal water-works system, consisting of approximately 2400 ft. of 6-in. class B cast-iron pipe; 500 ft. 10-in. class C cast-iron pipe; 23,700 ft. 10-in. 75-lb. pressure wood-stave pipe; 3300 ft. 10-in. 125-lb. pressure wood-stave pipe; 1300 lb. special castings; 16 ft. x 20 ft. brick building; one 250-gal. per minute horizontal multi-stage turbine pump driven by a 30-hp, 200-volt, 60-cycle, single phase motor; one 450-gal. per minute horizontal, single-stage turbine pump driven by a 20-hp, 220-volt, 60-cycle, single-phase motor; one 250-gal. per minute horizontal multi-stage turbine pump driven by a 30-hp internal combustion engine; one well 22 ft. deep and 12 ft. in diameter, and a 6600-volt transmission line about 29,000 ft. in length. Plans and specifications may be seen at the office of the city clerk, Rushville, Ill., or in the office of the Fuller-Coult Company, engineers, Chemical Building, St. Louis, Mo. Extra sets of plans and specifications may be procured upon payment of $3 to cover cost of printing same.

TALLULA, ILL.—The local electric-light plant has been purchased by Abbott Brothers, of Petersburgh, Ill. The new owners have been granted a fifty-year franchise to operate an electric-lighting system in the village and a contract to light the streets of the village for a period of ten years. Sixty incandescent lamps of 50 cp will be installed. The new owners will overhaul the plant at once.

VIRDEN, ILL.—The electric plant of the Virden Electric Light Company has been leased to W. M. Stowell and B. F. Tucker, of Decatur, Ill., who will operate the same.

WASHBURN, ILL—The plant and holdings of the Washburn Electric Company are reported to have been purchased by Messrs. Hollenback & Vorhees, of Fairbury. It is understood that the new owners will make extensive improvements to the system and establish a twenty-four-hour service.

ANDERSON, IND.—The Board of Public Works has notified the merchants that the city will erect on all streets in the business section of the city lamp standards for cluster lamps, the posts to be 25 ft. apart. The city will agree to install the ornamental street-lighting system and prorate the cost in monthly instalments on the merchants' bills for electricity for lamps.

ANGOLA, IND.—It is reported that the plant of the Angola Railway & Light Company will be rebuilt. The property was purchased by Pittsburgh capitalists at a receiver's sale for $33,000.

KENDALLVILLE, IND.—The City Council has appropriated $5,000 for the installation of a boulevard lighting system. Standards for the new system have been ordered.

SOUTH BEND, IND.—The Chapin Park Improvement Association is contemplating the installation of new cluster lamps on Park Avenue from Navarre Street to the Cutter residence, Riverside Drive. It is understood that the necessary funds have been procured.

CEDAR RAPIDS, IA.—Plans are being considered for extensive improvements to the local power plant of the Rock Island lines which will involve an expenditure of about $49,000. It is expected that work will begin on the improvements next year. H. U. Mudge, of Chicago, Ill., is president of the company.

CORYDON, IA.—Bids will be received by the town of Corydon, Ia., until Dec. 5, for the reconstruction of the electric-light plant, including boilers, engine, generator and electrical apparatus. The Iowa Engineering Company, of Clinton, Ia., has charge of the engineering work. J. J. C. Bower is town clerk.

FAIRFIELD, IA.—The Commercial Club has submitted a proposition to the City Council relative to the installation of an ornamental street-lighting system in this city. It is proposed to have the citizens pay for the lamp standards and lamps and the city supply electricity to maintain same. Plans are also being considered to place the wires underground. The present plans call for the erection of 100 standards, each carrying five lamps.

KEOKUK, IA.—Plans are being considered to replace the arc lamps now in use on Main Street with electroliers, each carrying five lamps. If the change is made the city will bear part of the expense.

MANCHESTER, IA.—Work has begun on the erection of the new power house of the E. W. Hoag light and power plant, which was recently destroyed by fire. Orders have been placed for new machinery and electrical equipment.

MOUNT VERNON, IA.—W. S. Tasker, who has been granted franchises to install and operate electric-light systems in Mount Vernon, Lisbon, Springville and Stanwood, has paid into the treasury of Mount Vernon $4,000, the balance due on the $5,000 which he agreed to pay the town for the franchise. Work will soon begin on the installation of the system and connecting up various towns.

KANSAS CITY, KAN.—Bids will be received by G. B. Little, city clerk, City Hall, Kansas City, Kan., until Dec. 5 for furnishing all material and labor for erection upon foundations furnished by the city of an arc-lamp equipment called for in specifications and for furnishing 450 arc lamps, f. o. b. cars Kansas City, Kan.

LEAVENWORTH, KAN.—The report submitted by Burns & McDonald, Kansas City, Mo., consulting engineers, engaged by the city commissioners to prepare the plans for the pumping station, provides for the installation of a combined electric-light plant and pumping station, to cost approximately $800,000. The plans submitted provide for a water plant of about twice the capacity needed at present, a filter system and an electric-power plant with sufficient output to provide for lamps for the entire city.

WICHITA, KAN.—Plans are being considered for the installation of an ornamental street-lighting system in Wichita, 3 miles in length, at a cost of $10,126, the expense to be borne by the city at large.

CAMPBELLSVILLE, KY.—The electric plant of the Campbellsville Electric Light Company was destroyed by fire on Nov. 15, causing a loss of about $30,000. The company carried no insurance. Many improvements had recently been made to the plant.

AUGUSTA, MAINE.—The American Volsam Company, recently incorporated with a capital stock of $100,000, proposes to dig, mine or quarry clays, earths, minerals, etc., and also proposes to generate and sell electricity as an auxiliary to its principal business. E. J. Pike is president and L. J. Coleman treasurer of the company.

LEWISTON, MAINE.—The City Council has contracted with the Holyoke Machine Company, of Holyoke, Mass., for a new waterwheel and accessories. The improvements will cost about $1,500 and will increase the output of the plant by 150 hp.

MONSON, MAINE.—The Greenville Light & Power Company, of Greenville, Maine, is erecting another substation at the Portland-Monson slate quarry, near the one erected about a year ago.

SOUTH BREWER, MAINE.—The Eastern Manufacturing Company, of Bangor, Maine, is preparing plans to enlarge its pulp plant in South Brewer, work on which will begin next spring. The company has contracted with the Bangor Railway & Electric Company for electrical energy to operate its entire plant. The contract calls for 3000 hp.

BOLTON, MASS.—Plans are being considered for the installation of an electric-lighting system in Bolton.

BOSTON, MASS.—The Boston Finance Commission has reported adversely to the Mayor on the proposition to build a central power plant at Deer Island, to cost approximately $180,000. The commission stated that the fire risk from the present plant is not excessive and would not be greatly reduced by a new plant.

EASTON, MASS.—The Board of Selectmen has granted the Edison Electric Illuminating Company, of Brockton, Mass., a franchise to erect its transmission lines in certain parts of the town, including the village districts of North Easton, Unionville and Easton Centre.

GROVELAND, MASS.—Plans are being considered for extensions to the municipal electric-light plant to provide for the increasing demand for street and commercial lighting. An appropriation of $900 will be asked for.

LEICESTER, MASS.—The Selectmen have signed a contract with the Worcester Electric Light Company for lighting the streets of the town for a term of three years. Under the terms of the contract the company will furnish 40-watt tungsten street lamps at the rate of $16 each per year, which is a reduction of $2 per lamp paid under the old contract. The company will supply electricity to the town for other purposes at 15 cents per kw-hour.

NORTHAMPTON, MASS.—The Northampton Street Railway Company has been granted a franchise to extend its system in Northampton.

SEEKONK, MASS.—The Seekonk Electric Company, recently incorporated, has petitioned the State Board of Gas and Electric Light Commissioners for permission to issue $25,000 in capital stock for the purpose of establishing an electric-light plant to supply electricity in the towns of Seekonk and Swansea. The company, it is said, proposes to take over the property of the Narragansett Electric Light Company. Extensions will be made as necessary to furnish the towns of Swansea and Somerset with electrical service.

TAUNTON, MASS.—The East Taunton Street Railway Company is planning to build an electric railway from Middleboro to Kingston, via Plympton, where it will connect with a railway from Plymouth to Brockton and Whitman.

DETROIT, MICH.—At a meeting of the stockholders of the Detroit Edison Company held Nov. 15 the stockholders voted to increase the capital stock of the company from $9,000,000 to $15,000,000. At an early date $1,500,000 of the new stock will be offered to the stockholders, pro rata, at par.

MUSKEGON, MICH.—The United States Circuit Court has affirmed the decision of the lower court in the case of the Muskegon Traction & Lighting Company against the city of Muskegon in favor of the city. The company served an injunction against the city to prevent it from issuing $75,000 in bonds voted by the citizens for the installation of a municipal electric-light plant.

PONTIAC, MICH.—The large power plant of the Rapid Motor Vehicle Company was recently sold by the General Motors Company to the Pontiac Power Company. The plant was built by the General Motors Company, and was intended to supply light, heat and power to the Rapid and Carter car factories.

ANNANDALE, MINN.—The installation of an electric-lighting system in Annandale is reported to be under consideration.

DULUTH, MINN.—The Council has decided to submit the proposition to issue $700,000 in bonds, the proceeds to be used for the construction of a municipal electric-light, heat and power plant, to the voters at the general election to be held Feb. 6, 1912. If the bond issue carries, it may result in the purchase of the plant of the Duluth Edison Electric Company. The company has offered to make a substantial reduction in rates.

FOLEY, MINN.—The Battery Company, of Milwaukee, Wis., is reported to have received a franchise to install an electric-light plant in Foley. Otto Jensen is local manager.

GILBERT, MINN.—The School Board has decided to install an electric-power plant to supply electricity for lamps and motors for the new high school and the grade school. The cost of the plant is estimated at $2,500.

MINNEAPOLIS, MINN.—Following a conference between representatives of the Minnesota River Improvement & Power Company and Congressman R. C. Stevens, of St. Paul, Minn., a definite proposition for maintaining with the government's aid a 4-ft. channel as far as Morton will be made. The new depth will admit of utilization of power at certain points by the company.

FULTON, MO.—The City Council has granted the Buffum Telephone Company, which operates the local exchange, a new franchise. The company, it is understood, is contemplating the construction of a new plant in Fulton, to cost approximately $40,000.

KIRKSVILLE, MO.—The Kirksville Gas, Heat & Electric Company has increased its capital stock from $50,000 to $100,000.

LAMAR, MO.—Bids will be received by the city clerk of Lamar, Mo., for $70,000 water-works and electric-light bonds.

ST. CHARLES, MO.—The St. Charles Electric Light & Power Company has asked the City Council to consider an extension of its franchise for twenty years. The company's franchise expires in 1914 and the company offers a reduction in the price of electricity if granted the extension asked for. A special election will have to be called to submit the proposition to the voters.

ST. JOSEPH, MO.—Plans are being considered to enlarge the municipal electric-light plant to provide for commercial service. A committee has been appointed to look into the proposition of equipping the plant for commercial lighting. It is said that Eugene H. Spratt, president of the Public Utilities Commission, is in favor of the project.

ST. JOSEPH, MO.—The St. Joseph Railway, Light & Power Company has submitted a form of contract to the Board of Public Works for the installation of sixteen additional blocks of ornamental street lamps in the business district of the city. Under the terms of the contract the city is to pay $8,000 for conduits, the company is to install and maintain the lamp standards, and the property owners and tenants are to bear the expense of electricity for maintaining the lamps. The contract is for a term of five years.

MOORE, MONT.—The Citizens' Electric Company, of Lewiston, Mont., is installing a new street-lighting system in Moore. Motors will also be installed in the near future to operate the pumps of the municipal water-works system, which will soon be ready for operation. The electric company is contemplating a number of improvements to the local system. It expects to complete its transmission line into Hilger early in the spring.

ELY, NEV.—A movement is under way for the construction of a new electric light and power plant to supply electrical service in this city by E. K. Hutchinson and C. F. Rose, of Ely. It is proposed to lease the power station and distributing system owned by the Ely Light & Power Company.

SEARCHLIGHT, NEV.—Plans are being considered by the Marion Mining Company for the installation of electric-hoisting machinery.

WINNEMUCCA, NEV.—The Board of County Commissioners of Humboldt County has engaged Burns & McDonald, of Kansas City, Mo., consulting engineers, to prepare plans and specifications for the installation of an electric-light plant and water-works system at Winnemucca.

CONCORD, N. H.—Plans are being considered for the installation of an ornamental street-lighting system in Concord to replace the arc lamps now in use in the business section.

FITZWILLIAM, N. H.—The New Hampshire Electric Light Company, which recently purchased the plant and holdings of the Troy & Jaffray Electric Light Company and assumed its contracts, has applied to the Selectmen of Fitzwilliam for a franchise to erect a transmission line in Fitzwilliam to supply electrical service in this town. The company is planning to erect a transmission line from a point on the Connecticut River Company's line at Gardner through Winchendon to Fitzwilliam, Richmond and Winchester, N. H.

WINCHENDON, N. H.—The property of the Troy & Jeffrey Electric Light Company has been purchased by the New Hampshire Electric Light Company, recently incorporated. The new company has a contract with the Connecticut River Power Company for electrical power. It proposes to erect a transmission line from some point on the Connecticut Company's line at Gardner, through Winchendon, Fitzwilliam, Richmond and Winchester. The New Hampshire Electric Light Company has applied to the Selectmen of Winchendon for a franchise in this town.

KINGSTON, N. H.—The Public Service Commission has authorized the Exeter & Hampton Electric Company to engage in business in the town of Kingston.

MANCHESTER, N. H.—The Central New Hampshire Power Company has secured a right-of-way for the erection of a transmission line across Hillsboroough County, passing through Goffstown, Bedford, Merrimack and Hudson to the state line.

PLAISTOW, N. H.—The Plaistow Electric Light & Power Company has been granted permission by the Public Service Commission to construct and operate an electric plant to supply electricity for lamps and motors in Plaistow, and also to issue $1,500 in capital stock.

BLOOMFIELD, N. J.—The Town Council has authorized the Mayor and clerk to enter into a contract with the Public Service Electric Company to light the streets of the municipality for a period of five years. The Council has abandoned the project of establishing a municipal electric-light plant for the present.

NEWARK, N. J.—Proposals will be received at the office of the Board of Education of Newark, N. J., until Nov. 27 for furnishing labor and material to erect complete the regular and special lighting fixtures for the Central Commercial and Manual Training High School. Blank proposals may be obtained at the construction department of the Board of Education, 9-11 Franklin Street, Newark, N. J., where contract and drawings and specifications may be examined. R. D. Argue is secretary of the board.

LAS CRUCES, N. M.—The Mountain States Telephone & Telegraph Company, recently granted a franchise to operate a telephone system in Las Cruces, is planning to erect an exchange building, to cost about $60,000.

WILLARD, N. M.—Plans are being considered for the installation of a large electric power plant to supply electricity to operate pumps for irrigation purposes in Willard, N. M. The proposed plant will cost approximately $125,000. Harry Curtin, of Clarksburg, W. Va., is interested in the project.

DUNDEE, N. Y.—Owing to the Board of Trustees and E. L. Bailey, proprietor of the local electric-light plant, being unable to come to an agreement, the street-lighting service has been discontinued. The trustees are now unable to pay as much for the service as has been paid for the past two years, and the service offered at the new price, $1,600, was unsatisfactory to the board. Mr. Bailey offered to exchange the 80-cp lamps which are now used, or furnish the 80-cp lamps with a midnight service. The company has been receiving $1,800 for the past two years, which is more than the village should pay on the ratio of its tax. It is said that Mr. Bailey proposes to submit the matter to the Public Service Commission.

GREENE, N. Y.—A special election was held Nov. 23 to vote on the proposition to purchase new electrical equipment for the municipal electric-light plant, including one 50-kva, 1200-volt, single-phase, 60-cycle Westinghouse generator; one 75-kw exciter, one switchboard panel, with necessary instruments complete, and a new set of field coils for the Westinghouse generator now in use.

LITTLE FALLS, N. Y.—The Utica Gas & Electric Company has submitted a new bid to the Council for lighting the streets of the city. The company offers to supply arc lamps at the rate of $75 per lamp per year for a period of five years, with provision that if the city should establish a municipal lighting plant inside of one year the contract would terminate at that time. The company submitted a bid a short time ago offering to supply the service at $82.13.

MEDINA, N. Y.—The Public Service Commission, Second District, has authorized the A. L. Swett Light & Power Company, of Medina, N. Y., to exercise franchises granted by the town of Somerset in the village of Barker, which provide for the erection and operation of an electric-light plant in those localties.

NEW YORK, N. Y.—Sealed bids will be received by Patrick A. Whitney, commissioner of correction, until Nov. 28 for furnishing labor and material for rewiring buildings known as the kitchen and laundry in the Boys' Reformatory and warden's house on Hart's Island, New York, N. Y. Blank forms and further information can be obtained and plans and drawings may be seen at the office of the Department of Correction, Borough of Manhattan, 148 East Twentieth Street, New York, N. Y.

ROCHESTER, N. Y.—The residents of South Fitzhugh Street are considering the question of installing a new lighting system on the streets between Spring and Troup Streets.

ST. JOHNSVILLE, N. Y.—The substation of the East Creek Electric Light & Power Company, at the western end of the village, was recently damaged by fire.

WARSAW, N. Y.—The plant and holdings of the Warsaw Gas & Electric Company have been purchased by Edmond D. Hamlin, of Avon, N. Y.; Ellis L. Phillips, of New York, N. Y., and George W. Olmstead, of Ludlow, Pa. It is said that new owners have purchased the plant at Perry, and are also negotiating for another plant in a nearby town.

CONCORD, N. C.—A deal has been closed whereby Bird S. Coler, of Coler & Company, New York, N. Y., and president of the North Carolina Public Service Company, Greensboro, N. C., has secured the controlling interest in the Piedmont Carolina Railway, of Concord, N. C. This company operates the Greensboro, High Point and other traction properties. It is understood that the Concord railway will later be extended to Salisbury as part of the interurban system.

SHELBY, N. C.—The Lily Mill & Power Company, of Shelby, N. C., has awarded contract for the construction of a steam power plant for use in emergencies and during low-water periods. The building will be about 32 ft. x 79 ft., and will cost about $5,000. The equipment will have a generating capacity of about 300 hp.

CLEVELAND, OHIO.—Bids will be received at the office of the Director of Public Service, City Hall, Cleveland, Ohio, until Nov. 28 for furnishing arc lamps with necessary transformers, regulators and converters or rectifiers for the municipal electric-light plant. A. B. Lea is director of public service.

DAYTON, OHIO.—The capital stock of the National Light Company has been increased from $50,000 to $100,000.

TOLEDO, OHIO.—The Toledo & Indiana Traction Company is preparing to extend its railway from Bryan, Ohio, to Angola, the eastern terminus of the Bucklen line.

EL RENO, OKLA.—The El Reno Interurban Railway Company is contemplating the construction of a new substation at Banner. The equipment will consist of one 300-kw rotary converter, three transformers and switchboard.

SULPHUR, OKLA.—The city of Sulphur, it is reported, has accepted the proposition of the Tecumseh Interurban Railway Company, under which the city is to give the company as a bonus a site for depot grounds and a franchise to operate the city line from the Artesian Hotel to Bromide Spring. Work is to begin on the proposed railway within six months.

CRESWELL, ORE.—Plans are being prepared by the Eugene Belt Line & Interurban Railway Company, recently incorporated, for the construction of an electric railway in Creswell. The citizens have raised a bonus of $25,000. P. C. Lavey is president of the company. The office of the company is located in Eugene, Ore.

ECHO, ORE.—Work has commenced on the installation of a street-lighting system in the business district of the city.

EUGENE, ORE.—Plans have been adopted for ornamental lamp standards for the street lamps on Willamette Street. Instructions have been given to order the necessary material. The first installation will require 110 standards, each carrying five 60-cp tungsten lamps. The Water Board proposes to extend the tungsten lamps through the entire city as soon as possible.

MEDFORD, ORE.—The Siskiyou Electric Company, which recently purchased the property of the Rogue River Electric Company, it is said, is planning to construct two new plants, one at Fall Creek, which will develop 4000 hp, and the other on the Klamath River, where 10,000 hp will be developed. The company proposes to combine all the plants in the same system, which, with the new Prospect plant and the plant at Gold Ray, will give the company a combined output of 27,000 hp. Announcement is also made that the company proposes to add two more units of 10,000 hp each to the Prospect plant. The Prospect plant is located in the mountains on the Crater Lake road, 50 miles from Medford.

NYSSA, ORE.—The Idaho-Oregon Light & Power Company has been granted a franchise to supply electricity in Nyssa. The company is planning to extend its transmission line from Boise to Weisner and the line will pass through this city. Several large pumping plants to be operated by electricity are being installed by the company in this section.

PORTLAND, ORE.—The River Mill dam and power house of the Portland Railway, Light & Power Company at Estacada was put into operation on Nov. 6. The plant when completed will generate about 30,000 kw.

ELIZABETH, PA.—The West Penn Electric Company, it is reported, is contemplating the construction of a large power plant on Cheat River.

JOHNSTOWN, PA.—The Southern Cambria Railway Company is planning to build a line to Colver and Carrolltown, a distance of about 10 miles, as soon as its extension from Johnstown to Ebensburg is completed.

SPRING CITY, PA.—Proposals will be received by the Board of Trustees of the Eastern Pennsylvania State Institution for the Feeble-Minded and Epileptic, care of Philip H. Johnson, architect, 1824 Land Title Building, Philadelphia, Pa., until Nov. 27, for the erection, furnishing and equipping of a power house and laundry for the Eastern Pennsylvania State Institution for the Feeble-Minded and Epileptic, at Spring City, Pa. Plans and specifications and form of contract may be secured on application to Philip H. Johnson, architect, 1824 Land Title Building, Philadelphia, Pa., for which a deposit of $100 will be required, which will be refunded on return of plans.

FLANDREAU, S. D.—At an election held recently the citizens voted to grant a franchise to C. Ladd to construct and operate an electric-light plant in Flandreau.

CHATTANOOGA, TENN.—The Chattanooga, Rome & Atlanta Railway Company, recently organized, proposes to build an electric interurban railway from Chattanooga through Fort Oglethorpe, Rome and all cities to Atlanta, in the heart of Georgia. The capital stock of the company in Tennessee is nominally placed at $100,000. The company will be chartered under the laws of Georgia, with a capital stock of $2,000,000. It holds franchises through Chickamauga Park secured by S. W. Divine years ago from the federal government. John H. Hill and associates are interested in the new company.

COWAN CITY, TENN.—It is reported that plans are being considered for the installation of a municipal electric-light plant in Cowan City.

AUSTIN, TEX.—Plans have been prepared for the construction of a 15-ft. dam across the Colorado River, a few miles below Austin, and for the installation of a small hydroelectric power plant for furnishing electricity for operating machinery for the farmers in that section and for irrigating several thousand acres of valley land. The cost of the proposed enterprise is estimated at about $50,000. D. B. Matthews, Charles Jones and Goodwin Jones are interested in the project.

BEAUMONT, TEX.—The Beaumont Electric & Power Company has been organized by the Stone & Webster Engineering Corporation, of Boston, Mass., which recently acquired the electric plant of the Beaumont Ice, Light & Refrigerating Company. The new company is capitalized at $880,000 and proposes to make extensive additions and improvements to the plant. It is reported that the company also proposes to build an electric railway from Beaumont to Port Arthur. The directors are: C. W. Kellogg, Jr., of Dallas, Tex.; Marshall Phinney, of Boston, Mass.; E. J. Emerson, of Beaumont, Tex.; L. C. Bradley, of Galveston, Tex.; David Daly, Harry L. Harding and W. A. Stevens, of Houston, Tex.

CALDWELL, TEX.—New equipment is being installed at the electric and ice plant of Womack & Nelms, including a 125-hp tubular boiler. A 75-kw generator has recently been installed, doubling the output of the plant.

DALLAS, TEX.—Arrangements are being made to double the output of the power plant of the Dallas Electric Light & Power Company, to provide for the increasing demand for electrical service. The present plant has a generating capacity of 5800 kw. The output of the plant will be increased by 5000 kw. It is understood that improvements will be made to the local street-railway system. The Dallas station will also supply energy to operate the Dallas-Waxahachie Interurban line, which will begin operation next year. Two substations will be erected, one near Lancaster and the other near Waxahachie.

DECATUR, TEX.—The City Council has purchased the local electric-light plant and water-works system, owned by J. F. Cooper, of Ft. Worth, Tex., for $10,000. The purchase is contingent upon the ratification of a bond issue sufficient to pay for the plant and to put the system in running order. Since the fire the town has been without electrical service. The water-works system is in operation.

GREENVILLE, TEX.—The City Council has granted a franchise to Joseph F. Nichols to construct an electric railway through the city. This railway, it is said, is part of an interurban line which Mr. Nichols and associates are interested in.

GREENVILLE, TEX.—Plans are being prepared for the construction of an electric railway between Blue Ridge and Gainesville, via Greenville, a distance of about 75 miles. It is expected that work will begin on the road about Jan. 1. A. Ralph Nicholson is interested in the project.

GEORGETOWN, TEX.—Extensive improvements are being made to the local water and light plant, which will involve an expenditure of about $50,000. An increased water supply has been secured by sinking a well.

HARLINGEN, TEX.—The City Council has engaged Randall, Lovegrove & Wyman, of Houston, Tex., to take charge of the construction of the proposed electric-light plant and water-works system, for which bonds were recently issued.

SAN ANTONIO, TEX.—The San Antonio Traction Company is planning to extend its South Flores street-car line to the irrigated gardens owned by F. F. Collins and others, a distance of about 1 mile.

SAN BENITO, TEX.—Plans have been adopted for the extension of the San Benito & Rio Grande Railway Company to Santa Maria. This extension, it is said, is to be completed by the first of the year. Plans are being considered for other extensions next year. Samuel Robertson, engineer and contractor, is at the head of the company.

SHERMAN, TEX.—Plans are being prepared for the installation of pumps and other machinery in the municipal electric-light and water plant in Sherman. Harvey McDuffie is superintendent.

TEXARKANA, TEX.—The Texarkana Gas & Electric Company is reported to have been given a bonus of $5,000 to build an extension of its railway from its present terminus in Rose Hill on Seventh Street to Westmoreland Heights.

TIMPSON, TEX.—The local electric-light plant, owned by Mrs. Warren Victory, has been purchased by George M. Bliss, of Warrensburg, Mo.

TIOGA, TEX.—The Tioga Traction Company, recently organized, contemplates the construction of an electric railway from Tioga to Gainesville, via McKinney, a distance of about 50 miles. J. P. Mason, M. Bradley, of Tioga, and others are interested in the project.

BURLINGTON, VT.—The court has modified the injunction brought by the Burlington Light & Power Company against the city whereby the city may make improvements to the municipal electric plant, the cost not to exceed $30,000. It also prohibits the city from entering into any further contracts for commercial lighting beyond those now existing until further order from the court.

ATTALIA, WASH.—The Pacific Power & Light Company has been granted a fifty-year franchise to erect transmission lines over the streets and alleys in Attalia. The Grinnell Company, which recently

purchased the Attalia irrigation project, is planning to install an electric pumping plant.

CENTRALIA, WASH.—The Washington Union Coal Company is planning to build an electric-light and power plant at its coal properties at Tono, Wash., to cost about $250,000.

HUNTSVILLE, WASH.—The Pacific Power & Light Company has applied to the County Commissioners of Columbia County for a franchise to erect and maintain transmission lines for the transmission and distribution of electricity and also to operate telegraph and telephone lines over and across the streets in Huntsville.

MILWAUKEE, WIS.—According to the present plans electricity for lighting the city hall will be supplied from the municipal incinerator plant after Feb. 1, 1912.

SHOSHONI, WYO.—The City Council has granted the Boysen Power & Irrigation Company a franchise to supply electricity in Shoshoni for lamps and motors for a period of twenty-five years.

NELSON, B. C., CAN.—Preparations are being made by the Athabasca Development Company for the installation of an electric plant at its mines in the Nelson district, near Nelson, B. C. It is expected that electrical equipment will be installed during the winter. Charles J. Riley is manager of the company.

OTTAWA, ONT., CAN.—Sealed tenders will be received by C. J. Desbarats, deputy minister of naval service, Department of the Naval Service, Ottawa, Ont., Can., until Nov. 28 for supply of copper and brass sheets, bars, tubes and copper wire for electrical circuits. Forms of tender and further particulars may be obtained on application to the above office.

OTTAWA, ONT., CAN.—Plans are being considered for developing three rapids in the St. Lawrence River, entirely in Canadian territory, the Cedars, Cascades and Coteau. Sir Max Aitken, who organized the Canadian cement trust, is at the head of an English syndicate which proposes to organize a company to be capitalized at $100,000,000 with a charter from the Dominion government. The project is supposed to be an enlarged merger of several companies already interested in power enterprises along the St. Lawrence River above Montreal.

PORT COLBORNE, ONT., CAN.—It is reported that plans are being considered by the Niagara, St. Catharines & Toronto Railway Company to extend its railway from Port Colborne to Fort Erie, and from there to Niagara Falls.

TORONTO, ONT., CAN.—The City Council is considering the question of submitting to the ratepayers on Jan. 1, 1912, a by-law to appropriate $1,500,000 for the completion of the municipal electric-light plant. The original amount voted by the ratepayers was $2,750,000, making the total cost of the system $4,250,000.

AGUA CALIENTE, SONORA, MEX.—Preparations are being made by C. W. Phillips and associates for the installation of a 100-ton electrostatic plant and electric transmission line at their Penn-Sonora mine at Agua Caliente.

IXTLAN, MEX.—The Navidad Mining Company is reported to have made application to the federal government for a concession to build a hydroelectric power plant upon the Navidad River, near Ixtlan. The company proposes to construct a dam across the river and erect a transmission line from the power plant to its mines.

VERA CRUZ, MEX.—It is reported that the local electric street-railway system has been purchased by American capitalists. It is understood that the new owners will make extensive improvements to the property and construct new lines.

New Industrial Companies.

THE BONFORD MANUFACTURING COMPANY, of New York, N. Y., has filed articles of incorporation with a capital stock of $25,000 to manufacture and sell motor vehicles, etc. The incorporators are: George Brauburger, 1026 Lafayette Street, Elizabeth, N. J.; Edward I. Kleinfeld, 502 West 173d Street, and Morris Klein, 80 East 116th Street, New York, N. Y.

THE ELECTRIC ENGINEERING COMPANY, of Sioux City, Ia., has been incorporated with a capital stock of $10,000 by E. L. Snyder, Harry J. Ryan and Ralph A. Oliver.

THE ENOS & WATKINS COMPANY, of New York, N. Y., has been incorporated by Alanson T. Enos, 120 East Seventy-fourth Street, New York, N. Y.; Howard E. Watkins, 15 Blackburn Road, and Francis K. Nelson, 11 Blackburn Road, both of Summit, N. J. The company proposes to manufacture gas and electric fixtures.

THE HULBERT ELECTRIC-STEAM MANUFACTURING COMPANY, of San Francisco, Cal., has been chartered with a capital stock of $50,000 by A. C. Hulbert, G. H. McKissick, C. E. Freshour, C. V. and N. J. Caruso.

THE LIGHTING STUDIOS COMPANY, of New York, N. Y., has been incorporated by L. W. Young, G. V. Kent, of New York, N. Y., and S. Dickson, of Hoboken, N. J. The company is capitalized at $40,000 and proposes to manufacture and deal in electric fixtures, chandeliers, etc.

New Incorporations.

PUEBLO, COL.—The Arkansas Valley Railway, Light & Power Company has been incorporated with a capital stock of $10,000,000 by W. F. Raber, T. H. Devine, and F. W. Insull. The company proposes to build an electric railway connecting Pueblo with the towns and cities in the Pueblo Valley. The company plans to penetrate the agricultural region along the Arkansas Valley and erect transmission lines on both sides of the river to supply the farmers with electricity for irrigation purposes.

WILMINGTON, DEL.—The Southern Idaho Water Power Company has filed articles of incorporation under the laws of the State of Delaware with a capital stock of $1,500,000. The incorporators are: F. H. Shive, S. E. Roberson, Harry W. Davis, all of Wilmington, Del.

NEZ PERCE, IDAHO.—Articles of incorporation have been filed for the Lewis County Electric Company with a capital stock of $200,000 for the purpose of operating an electric-light and power plant. C. F. Cunningham is agent of the company.

Personal.

DR. EDWARD G. ACHESON delivered an address, by special invitation, before the Society of Chemical Industry, London, on Nov. 7, on the subject of "Deflocculation."

MR. J. A. WALLS, chief engineer of the Pennsylvania Water & Power Company, Holtwood, Pa., who has been ill from overwork for the past three months, has returned to his post at McCall's Ferry greatly improved in health.

MR. R. L. THAYER, well known in the electrical field in the West, is now manager of the electrical department of the Lester-Hiland Company, dealer in specialties for steam and electric railways, with office in the Railway Exchange, Chicago.

MR. K. B. THORNTON, chief engineer of the operating department of J. G. White & Company, New York, has resigned to accept the post of chief engineer and operating manager of the Canadian Light & Power Company, of Montreal, Quebec.

MR. J. L. ROBERTSON, formerly the general manager of the Electrical Installation Company, of Baltimore, has joined the Consolidated Gas, Electric Light & Power Company, of Baltimore, and will have charge of its house and store wiring department.

MR. W. L. MANN, superintendent of operation of the Shawinigan Water & Power Company, Montreal, Quebec, has severed his connection with that company and entered the employ of the York Haven Water & Power Company, York Haven, Pa., as general manager.

MR. R. G. BLACK, superintendent and chief electrician of the Toronto Electric Light Company, Toronto, Ont., sailed on the S.S. *Baltic* from New York, Nov. 15, for a three months' sojourn in Europe in quest of health. Mr. Black has been ailing for some time and will consult eminent specialists on his case.

MR. FREDERICK B. EAVES has accepted a position on the commercial staff of the Bryant Electric Company in New England and New York State. He had previously been connected with Stone & Webster and the Boston Edison Company and more recently with E. W. Ham, of Worcester, Mass., in which position he acquired very valuable experience.

MR. FRED W. HULME, formerly with Rumsey Brothers, of Philadelphia, has joined forces with the Triumph Electric Company in its sales department and will be attached to the New York office. Mr. Hulme will specialize on motor application for machine-tool drive work and particularly on the new line of Triumph alternating-current motors for elevator service, etc.

MR. L. R. SCHNEIDER, secretary to Mr. David Daly, general manager of the Houston Electric Company, of Houston, Tex., met with a fall of 100 ft. from an aeroplane piloted by Aviator Bonney at Houston on Nov. 15. Both men were buried beneath the wreckage of the machine but managed to escape unhurt. The arrangements of the aviation meet were in charge of Mr. Daly as chairman of the committee.

MR. H. L. PARKER has resigned as illuminating engineer of the Consolidated Gas, Electric Light & Power Company, of Baltimore, in which capacity he had charge of store-lighting and electric-sign campaigns and organized a house-wiring department. Upon his departure Mr. Parker was tendered a farewell supper by the commercial department of the company. Mr. Parker will soon take up another line of work, and until then his address will be Geneva, Ohio.

MR. RICHARD P. READ has been appointed manager of the new-business department of the Montreal Light, Heat & Power Company, Montreal, Quebec, vice Mr. B. G. McNabb, whose death from accident was noted in these columns Nov. 11. Mr. Read was born in New York City, May 19, 1881, and graduated from Cornell in 1901. For eight years he was engaged in advertising and sales-promotion work in New York, and for the past two years he has been located in Montreal with the gas and electric interests.

MR. GLENN C. WEBSTER, manager of the engineering department of the National Electric Lamp Association, Cleveland, started Friday, Nov. 17, on an extended Western trip. On Friday afternoon he gave

an address on the "Value of Co-operation in Modern Business Enterprises" at the banquet of the National Cloak and Skirt Manufacturers' Association, at Toledo. He is now on his way to Los Angeles, where he will have general oversight of the National Electric Lamp Association's exhibit at the electrical "Fiesta" exposition. Mr. Webster expects to make a study of industrial conditions in San Francisco and other Coast cities, returning to Cleveland late in December.

GEN. GEORGE H. HARRIES, president of the Louisville Lighting Company and the Louisville Gas Company, was tendered a testimonial banquet at the Willard Hotel in Washington, D. C., by the citizens of that community, which he served in various capacities for many years. He received a number of handsome gifts, including a silver service from the citizens and another from the Washington Railway & Electric Company; a smoking outfit and table from the baseball team of the Board of Trade, and a portfolio of testimonials from business men. Toasts to General Harries in his various capacities of newspaper man, soldier, civic worker, citizen and constructive genius were responded to by many prominent guests, including Mr. H. M. Byllesby, of Chicago.

MR. G. LOBO, who has joined the technical staff of the Kelvin Engineering Company, recently incorporated, and with offices at 78 Wall Street, New York, is a full member of the A. I. E. E., and has been doing engineering work in New York City since the beginning of this year. Previous to that time he was located in Mexico City, where he was a member of Victor M. Braschi & Company, in the general electrical contracting and machinery business. Mr. J. H. Shearer, who has joined the same company, has been connected with various enterprises the last three years in the South, and more lately in New York. Previous to that time he was in the contracting business in the city of Mexico, under the name of the Shearer Electric Construction Company.

MR. JAMES G. POMEROY, for seventeen years manager of the Chicago office of the Adams-Bagnall Electric Company, will be sales manager of that company with headquarters in Cleveland ,after Jan. 1. Mr. Pomeroy made his entrance into the electrical business with the old Electrical Supply Company of Chicago in 1888. In 1891 he went with the Brush Electric Company, and three years later he engaged with the Adams-Bagnall company. Few electrical men in the West have a wider circle of acquaintances than "Jim" Pomeroy, as he is called by his intimates, and his record has been one of success. He was one of the organizers of the Electric Club of Chicago, of which he was a member of the board of managers for two years and treasurer for one year. He is also an associate of the American Institute of Electrical Engineers, and a statesman-at-large of the Sons of Jove. His promotion is well deserved.

MR. JACQUES ABADY, M. I. M. E., a director of the English firm of Alexander Wright & Company, Ltd., engineers and manufacturers of measurement and control apparatus, sailed for London via Quebec, Nov. 17, after a two weeks' visit with Alexander Wright & Company's American branch, the Precision Instrument Company, of Detroit. In addition to his business activities, Mr. Abady is a barrister, chairman of the works committee of the Council of Westminster, and is the author of "Abady's Gas Analyst's Manual," published in this country; "Coal and Common Sense," "The A B C of Combustion," and other contributions to technical literature. He is one of the co-inventors of the Simmance-Abady combustion recorder, Simmance-Abady vacuum and pressure gages and other apparatus for testing various conditions of steam, gas, water and air. His visit was partly with the object of discussing several new inventions, which have passed the experimental stage and which will shortly be on the market for general use in steam and gas plants.

MR. L. R. POMEROY, New York, N. Y., has resigned as chief engineer of the railway and industrial division of J. G. White & Company, Inc., New York, to open an office as a consulting engineer in New York. Mr. Pomeroy will make a specialty of the design of railway and industrial plants, the rehabilitation of shops and the analysis of machine-tool operation with relation to electric and effective operation, and will prepare reports and appraisals of railway and manufacturing properties. In this line of work Mr. Pomeroy has had a long experience and has become an authority. He was assistant general manager of the Schenectady Locomotive Works from 1899 to 1901. From 1901 to 1908 Mr. Pomeroy was special representative of the railway department of the General Electric Company, where he specialized on the electrification of steam roads, railway shop applications, etc. For the two years following he was assistant to the president of the Safety Car Heating & Lighting Company, and in 1910 he resigned from that company to join J. G. White & Company, Inc. Mr. Pomeroy will have his office at 50 Church Street, New York.

MR. PHILIP S. DODD, director of publicity of the National Electric Lamp Association, has just returned from an extended trip to the Pacific Coast, made in behalf of the Commercial Section of the National Electric Light Association, of which Mr. Dodd is secretary. The trip was made with the particular idea in mind of meeeting the necessities of the commercial man's problems in every section of the country. Mr. Dodd visited in turn Denver, Salt Lake City, Reno, San Francisco, Portland and Seattle, returning through San Francisco, Reno, Denver, Minneapolis and Chicago. Following the Jovian convention at Denver, Mr. Dodd was appointed national statesman of that order. In Seattle, in conjunction with Mr. H. M. Winters, the energetic manager of the sales department of the Seattle Electric Company, a lunch club was formed to effect a co-operation of the electrical interests of the city, to devise ways and means for assisting the local committee in the entertainment of the delegates to the Seattle convention of the National Electric Light Association, to promote the work of the commercial section in that part of the country, and to work toward the introduction of a people's electrical page similar to that conducted by the electrical interests in other sections. At San Francisco a complimentary luncheon was given to Mr. Dodd by Messrs. John F. Britton, T. E. Bibbins and E. B. Strong, at which he referred incidentally to the value of co-operative effort in various sections of the country and emphasized the very satisfactory results which had followed the introduction of the "Co-operative Electrical Page" in other cities. A lunch club was also formed at San Francisco to carry on a work similar to that indicated in the case of Seattle. Mr. Dodd will stay for a short time in Cleveland, and will then go to New York to organize the central bureau of the commercial section, and on Dec. 1 will open an office at 29 West Thirty-ninth Street, where the work will be carried on in close connection with the office of Secretary Martin.

Obituary.

MR. GEORGES D'INFREVILLE died last week in New York City. Mr. d'Infreville was born Feb. 23, 1846, at the Château de Creullet, near Caen, Normandy, France. By his paternal grandmother he was a direct descendant of the Marquis de Dupliex, the celebrated governor of French India, and another ancestor, the Marquis d'Infreville, was superintendent of the French navy under Cardinal Richelieu. Mr. d'Infreville had the right to bear title, which, however, he disclaimed, stating on one occasion that as an American citizen he did not believe in titles. He received a collegiate education and was appointed to the Military Academy of St. Cyr, receiving upon graduation a commission in the Fench army. He served as an officer during the Franco-German war, being preesnt at the battles of Borny, Rezonville and Gravelotte. Mr. d'Infreville came to America in 1872, and soon afterward invented a successful duplex system of telegraphy, selling the right of use to a number of telegraph companies and to the Pennsylvania Railroad Company, the patent finally being purchased by the Western Union Telegraph Company. He also invented a telephone call system, which was sold to the Bell Telephone Company. Mr. d'Infreville was chief electrician of the Atlantic & Pacific Telegraph Company, and later, for five years, dating from 1881, was chief electrician for the Western Union Telegraph Company. During this stage of his career he frequently appeared in the courts as an expert in electrical and telegraphic litigation. After leaving the Western Union Company he took up the manufacture of batteries for telegraph use.

MR. GEORGE W. HEBARD, acting vice-president of the Westinghouse Electric & Manufacturing Company, died at his home in New York City on Friday, Nov. 17. Mr. Hebard was born in Barre Center, N. Y., in 1845, and was therefore sixty-six years of age. He had been in poor health for some time previous to his death. Mr. Hebard was identified with the early history of the manufacture of electrical apparatus, becoming president of the United States Electric Lighting Company of Newark in 1882, and had associated with him, as directors, Messrs. Marcellus Hartley, Anson Phelps Stokes, Charles R. Flint, Henry B. Hyde, Charles F. Brooker, Leonard Curtis, and other well-known men. Mr. Hebard was connected with the early history of the generation and distribution of electricity for lighting in New York City as a director and stockholder of the United States Illuminating Company. In this position he had to do with the equipment of the Weston lighting system on the Brooklyn Bridge, parts of which are still in service. Later, as president of the United Electric Light & Power Company, he was closely affiliated with the introduction of the alternating-current system in New York City by means of the overhead system. He was active later on in the change of the distribution system from the overhead to underground. The improvement of the system of distribution from the standpoint of the central station was also one of his most successful labors. At the time the United States company was taken over by the Westinghouse company, Mr. Hebard was president of the United company, and in the re-organization he was made vice-president of the Westinghouse company, and in 1888, when this company took over the Sawyer-Man company, Mr. Hebard received charge of the newly acquired organization. Besides his active participation in his chosen profession, Mr. Hebard was also very active in social, religious and philanthropic work in New York. He was a member of the Tompkins Avenue Congregational Church, Brooklyn, having been superintendent of the Sunday school for some time. He was a man of genial disposition, keen judgment, and a business man with a wonderful grasp of affairs. He was a member of the Union League, the Lawyers', the Engineers', and several other clubs.

GEORGE W. HEBARD.

Mr. Hebard leaves a widow and two sons, Charles R., who is in the cotton business, and Arthur, who is in the ammunition business, in which his father was engaged prior to entering the electrical profession. The funeral took place from the Tompkins Avenue Congregational Church on Monday, Nov. 20.

MR. CARYL DAVIS HASKINS, manager of the lighting department of the General Electric Company, died in Salt Lake City on Nov. 18, after an attack of pneumonia lasting only two days. Mr. Haskins was born in Waltham, Mass., in 1867 and obtained his early education in the public schools of Philadelphia and Dedham. In 1879 he went to England and attended the Allison Towers and Roslyndale schools, devoted to the preparation of boys for military and engineering work. Later he studied under the London University tuition system for about a year, but finally gave up the idea of a university course and returned to the United States, where he took up the study of biology. This was in 1887, and in the same year he again returned to England and entered the employ of Haskins, Davis & Company, of London and Boston, Mass., from which engagement the commencement of his technical work dates. After about six months, during which time he specialized on gas-engine work, Mr. Haskins entered the shops of S. Z. de Ferranti. Commencing at the lowest round of the ladder, he was advanced to the meter department, of which he became foreman. During this period he was also connected with some of the early work at the old Grosvenor and Deptford stations. Returning again to the United States, in 1889 Mr. Haskins entered the employ of the Thomson Electric Welding Company, at Lynn, Mass., in the capacity of designing draftsman, but was almost immediately transferred to the Thomson-Houston Electric Company as assistant foreman of the meter department at Lynn. Shortly afterward he was transferred from the shop and given charge of the company's outside meter interests. The consolidation resulting in the formation of the General Electric Company gave Mr. Haskins another promotion and placed him at the head of the meter interests of the consolidated company. In 1893 he was given, in addition, charge of the company's instrument department. In 1900 his responsibilities were again enlarged by including the switchboard department, which appointment necessitated his removing his office from Boston to Schenectady. While Mr. Haskins is professionally best known as a meter expert, he was an inventor in several branches. Among a score of patents granted to him are included the subjects of steel refining, meters, transformers, switches, circuit-breakers, time relays, etc. Perhaps his most important invention, as well as the most ingenious, is an auto-dirigible torpedo. For obvious reasons the principles of this torpedo have never been described in print. Mr. Haskins refused advances from foreign powers relative to this invention. During odd hours Mr. Haskins found time to devote to literary work. In 1892 he became the author of a book on transformers, which answered an excellent purpose in its day when printed information on this subject was very meager and eagerly sought. Of an entirely different nature is a book entitled "For the Queen in South Africa," a work of fiction consisting of six war stories. Since 1898 he had been in demand as a lecturer before the various army and navy institutes, and he had lectured and prepared papers for the War College, Washington; the School of Submarine Defence at Fort Totten, the Signal Corps School at Fort Leavenworth, Kan., and the Franklin Institute. He was scheduled to deliver an address on Feb. 19, 1912, before a local section of the National Electric Light Association on "The Electric-Lighting Industry, Past, Present and Future." Mr. Haskins was a contributor to the *Transactions* of the American Institute of Electrical Engineers, the National Electric Light Association, the Association of Edison Illuminating Companies, the American Street Railway Association, the Northwestern Electrical Association and other electrical organizations. He also contributed many articles to the periodical press. When the rupture with Spain seemed probable Mr. Haskins promptly volunteered his services to the United States government. Having submitted a plan for raising a volunteer corps for submarine mining, coast and harbor defense, he was summoned before the chief of engineers, and his plans were approved. Upon his return to Boston he raised a battalion of electricians, numbering 160 men, immediate command of which body was given to him. This battalion was the first volunteer organization called out for military duty in connection with the Spanish War and was quietly at work some ten days before war was declared. Among other things, it mined Boston Harbor, installed searchlights in the harbor system of fortifications, erected and cared for a system of range and position finders, put up telephone and telegraph lines and planted submarine mines. At the conclusion of the war Mr. Haskins resumed his position with the General Electric Company. He had made a special study of electricity as applied to offense and, particularly, defense in time of war and was considered an authority on this subject, and after the close of the war he frequently acted in an advisory capacity to the government in matters of this nature. Mr. Haskins was a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the National Electric Light Association and was an associate member of the Military Service Institute and the United States Naval Academy. Mr. Haskins was very prominent in Schenectady society, being a member of the Mohawk Golf Club, the Mohawk Club, local branches of various engineering societies and the Antlers' Golf Club of Amsterdam. He was also a member of the Engineers' Club of New York and the Massachusetts Society of the Sons of the Revolution. He was greatly beloved by all his associates and had an unusually wide circle of friends who will long cherish the memory of his charming versatility and brilliant intellect. He is survived by a widow and one son, who were with him at the time of his death. Temporary interment of the body was made at Schenectady, where a brief funeral service was held on Nov. 22.

CARYL D. HASKINS.

IN MEMORIAM. CARYL DAVIS HASKINS.

The profession of electrical engineering has lost a beloved and distinguished member and his country a stanch patriot in the demise of Caryl Davis Haskins, who died of pneumonia in Salt Lake City, Saturday, Nov. 18. The bereavement is doubly poignant in that he was suddenly stricken down in the flower of his manhood with his career of distinguished achievement ever opening wider before him.

He was born in Waltham, Mass., May 22, 1867, and came by his intellectual power of good right, since he was the son of John S. Haskins, who in his youth had been John Ericsson's chief constructor on the *Monitor,* was later one of the engineers in charge of boring the Hoosac Tunnel and a generation ago was a conspicuous figure in mechanical engineering. The son, a victim in his childhood of a terrible fall which checked his stature but could not quell his physical activities or his splendid intellectual powers, went as a boy with his father to England and received his education mainly in English schools, including London University.

At one-and-twenty he was an electrical engineer with Ferranti in the beginning of the first great experiments with alternating-current lighting. Returning to his native country in 1889, he joined the forces of the Thomson-Houston company at Lynn and soon received charge of the electric-meter department, which he steadily built up for the next decade. A firm believer in the inherent equity of metering electrical energy, he devoted his great ingenuity to the improvement of the meter as an instrument, and labored assiduously and successfully to bring it into universal use in central-station supply. His inventions in the art of metering electricity and in kindred matters were numerous and important and his papers on the theory and practice of metering were no small factor in the steady growth of the art.

His mind was singularly versatile and the scope of his technical activities extremely wide. He early became intensely interested in the problems of national defense, especially with reference to torpedo warfare, and did some immensely interesting work in the development of dirigible and auto-dirigible torpedoes. The premonitory symptoms of the Spanish-American war found him with these very problems uppermost in his mind. He realized fully both the need for coast defense and the terrible state of unpreparedness in which the country groveled during the gloomy weeks that followed the destruction of the *Maine.* Finding that Boston was then practically without means of defense, and that the Corps of Engineers had neither sufficient men nor adequate material with which to extemporize defenses, he set himself the task, weeks before the outbreak of hostilities, of organizing a volunteer corps composed of trained engineers in various lines of activity, who could be put at the disposal of the United States Corps of Engineers to carry on its work efficiently and quickly. So assiduous and successful in this work was he that a three-company battalion of engineers was organized, officered and put in close touch with the United States engineers a month before the war broke out. It was ready for service at an hour's notice, fully organized, had its entire program of work laid out for it and was in fact the first volunteer organization of any kind actually put into service for the war, for it was called out and set to work on the submarine defenses of Boston Harbor, laying cables for communications, loading and laying mines, building signal and range-finding stations, before there was any authority under which it could be mustered in as a military body and two weeks prior to the firing of the first gun. Mr. Haskins was in chief command of this organization and during its term of service carried the responsibilities and did the work of a major of engineers.

From the experience thus gained his interest in national defense was even more keenly aroused than before, and he devoted much energy to the development of submarine mining apparatus, so that the system now used in the United States service is in no small measure of his personal devising, and since that time he had been closely affiliated with the military and naval organizations, being a member both of the United States Naval Institute and of the Military Service Institution.

Shortly after the war the scene of his activities was transferred to the Schenectady works of the General Electric Company, where his widening sphere of influence soon made itself felt, and with his increasing responsibilities in other fields ended his more intimate association with electric metering. In later years he had charge of the immense lighting business of the General Electric Company, and no one was better known or more cordially liked by the central-station men of the country, whose friend and adviser he was to an extent that it is hard fully to realize. No man in the profession had more or warmer friends, and by them his death is most acutely felt.

His energy was ceaseless and found channels of outlet far beyond the confines of his purely technical work. He was a keen sportsman, a careful and observing naturalist. Always possessed of a love for literature, and with an alert imagination, he wielded a most facile and graceful pen, and his occasional short stories, published in current periodicals or gathered into a volume, as was the case with a particularly vivid group of military sketches, found a circle of readers even wider and more appreciative than those who had followed his many contributions to technical literature. An engineer of very unusual attainments, a warm and loyal friend and a man whose ideals of patriotism and righteousness never wavered, his loss is greatly to be deplored.

He leaves behind a sister, a devoted wife, from whom in life he was inseparable, and a young son, to whom the most heartfelt sympathy of a host of friends is extended. LOUIS BELL.

Trade Publications.

ALTERNATING-CURRENT GENERATORS. — The Allis-Chalmers Company, Milwaukee, Wis., has issued Bulletin No. 1075, devoted to belted-type alternating-current generators. The machines described are rated at from 50 kva to 900 kva.

EXPULSION FUSES AND FUSE HOLDERS.—The General Electric Company has just issued Bulletin No. 4899, illustrating and describing its expulsion fuses and fuse holders. These are for use on circuits having voltages up to and including 110,000.

ELECTRIC SHEET STEEL.—Follansbee Brothers Company, Liberty Street and Second Avenue, Pittsburgh, Pa., has prepared for distribution curve-sheets showing tests upon improved electrical steel. The data shown on the curves relate to the loss in watts per pound for various thicknesses of sheets at different densities in lines per square centimeter. Data are also given relative to the magnetizing force required for producing the different magnetic densities.

LIGHTING FIXTURES.—The Federal Sign System (Electric), Chicago, has just issued a bulletin covering the entire Federal line of fixtures, steel shades, lock clamp sockets and bushings, and supplies. An interesting new line of porcelain-enameled steel fixtures is one of the features of the bulletin. A complete line of porcelain-enameled steel shades of new design is another feature of the bulletin, including shades of both concentrating and diffusing types that can be used to make a variety of effective steel units. A new low-priced line of art-glass portables, hall lamps and pedestals occupies several pages. The bulletin, as a whole, makes a complete and handy catalogue for the fixture dealer, central-station salesman or any electrician interested in the subject of illumination.

BATTERY TRUCK CRANE.—The General Electric Company has just placed on the market a new piece of apparatus known as a battery truck crane, which the company describes in its Bulletin No. 4892, recently issued. The machine is a short, heavy storage-battery vehicle having mounted on its forward end a swinging crane, the hook of which is raised and lowered by a 1-ton hoist operated from the vehicle battery. The vehicle is used in loading, hauling and unloading trailers, loading and unloading cars, hoisting and carrying on the hook boxes or barrels, and for stacking. The running of the vehicle, hoisting and carrying are controlled by one man. The crane is equipped with special attachments to suit the carrying on of the work contemplated, and the height can be made to suit local conditions. The bulletin contains illustrations of the truck and crane in use and describes also various pieces of apparatus used in connection with it.

BUSINESS NOTES.

MR. A. C. WILES, who formerly represented the A & W Sign Company in Baltimore, has taken charge of the company's Albany office. The Blumenthal-Kahn Electric Company has taken over the Baltimore agency for the sign company.

THE VALENTINE-CLARK COMPANY, of Minneapolis, has opened a sales office at St. Marie's, Idaho, for the handling of Northern and Western cedar poles in all points west of the Dakota-Montana line, in the State of Colorado and west thereof, and also in Texas. The office has been placed in charge of Mr. Neil Burrell and Mr. L. H. Clark.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has recently opened a district office in the Farmers' Bank Building, Pittsburgh. Formerly the Triumph company was represented by the Doubleday-Hill Electric Company in that territory, but the rapidly increasing business made it seem advisable to have direct representation in this important center. Mr. D. D. Gill will be in charge of the new office.

PRINTING-PRESS CONTROL.—Mr. C. B. Callow, London representative of Kohler Brothers, of Chicago, is in the United States and has been spending a little time in Chicago. Mr. Callow is engaged in the business of selling the system of electric printing-press control originated by Kohler Brothers, the foreign rights of which are still controlled by that firm, although the apparatus is made and sold in the United States by the Cutler-Hammer Manufacturing Company. It is reported that there has been an excellent foreign demand for this ingenious control.

BRUCE-MACBETH GAS ENGINE SALES—A long list of recent sales by the Bruce-Macbeth Engine Company, Cleveland, Ohio, of vertical multo-cylinder gas engines, aggregating twenty-six engines, ranging from 35 hp to 350 hp, includes a number for electrical generation, as follows: To the Prospect Garage, Cleveland, 35-hp engine for storage-battery work; Patapsco (Md.) Electric & Manufacturing Company, 300-hp engine for municipal lighting; Exide Battery Depot, Cleveland, 135-hp engine, a second order; city of Canal Dover, Ohio, for municipal lighting, 300-hp engine, a second order; Hotel Southland, Dallas, Tex., 250-hp engine for elevators and lighting.

THE AMERICAN MILKING MACHINE COMPANY.—In the issue of April 20 an electrically driven milking machine was described which in its working principles departs materially from any other invention in this line. The American Milking Machine Company, which was recently formed for marketing this machine, has established offices at 29 Broadway, New York City. Mr. G. P. Wern is the president of the company and Mr. A. E. Sylven is general manager. Machines have been in actual service at several farms for some months past and the result is reported to be very satisfactory. At the recent Land and Products Show at Madison Square Garden, New York, the company had an interesting exhibit showing the machine in actual work.

Weekly Record of Electrical Patents

UNITED STATES PATENTS ISSUED NOV. 14, 1911.

[Prepared by Robert Starr Allyn, 16 Exchange Place, New York.]

1,008,313. FIRE-ALARM SYSTEM FOR TELEPHONE EXCHANGES; W. L. Denio, Rochester, N. Y. App. filed April 5, 1909. Alarm call box sends code number to central operator.

1,008,320. PULL-CHAIN GUIDE; E. H. Freeman, Trenton, N. J. App. filed June 21, 1911. The body has a lateral opening and is attached to the shell of a lamp socket and the mouthpiece screws onto the body.

1,008,326. ELECTRIC-CURRENT-SHUNTING DEVICE; R. W. W. Grigbsy, Los Angeles, Cal. App. filed Oct. 24, 1910. Looped resistance and slidable short-circuiting elements.

1,008,370. AUTOMATIC FIRE ALARM; L. Robillot, Besancon, France. App. filed Dec. 1, 1909. A twisted strand cable and a helically grooved carrier.

1,008,383. PROCESS FOR CONVERSION OF LOWER OXIDES OF NITROGEN TO HIGHER OXIDES OF NITROGEN; F. Sparre, Wilmington, Del. App. filed Sept. 7, 1907. Electrolysis of the residual acids derived from nitration of cellulose and glycerine.

1,008,391. METHOD OF CONTROLLING VAPOR ELECTRIC APPARATUS; P. H. Thomas, East Orange, N. J. App. filed Feb. 9, 1904. A red-ray-supply gas is introduced and the vaporization of the mercury is retarded.

1,008,392. ELECTRIC SWITCH MECHANISM; G. S. Tiffany, Summit, N. J. App. filed Oct. 28, 1907. A plurality of pivoted keys for a number of circuits.

1,008,408. TELEPHONE-RINGING DEVICE; H. N. Faris, Kansas City, Kan. App. filed March 22, 1909. A relay changes a direct ringing device into an inductive ringing device on an overload.

1,008,411. SAFETY DEVICE FOR ELECTRICALLY HEATED IMPLEMENTS; H. A. Hills, Grand Rapids, Mich. App. filed Nov. 9, 1908. A fuse device for sadirons, etc.

1,008,423. ELECTRICAL CONDUCTOR; H. L. McIntyre, New York, N. Y. App. filed March 27, 1906. Polycircuit cable for telephones, etc.; untwisted but segregated mates to prevent cross-talk.

1,008,452. SELECTIVE SIGNALING SYSTEM; V. Durbin, Brookline, Mass. App. filed May 16, 1910. Train-dispatching telephone system; synchronizing apparatus. (Fifty-three claims.)

1,008,453. CONTROL SYSTEM FOR ELECTRIC MOTORS; A. C. Eastwood and H. F. Stratton, Cleveland, Ohio. App. filed March 18, 1910. For slow-speed lowering of hoisting systems.

1,008,454. ELECTRIC CONTROLLER; A. C. Eastwood, Cleveland, Ohio. App. filed Sept. 24, 1910. Separately actuated magnetic starting switches with means for holding the main switch in case any cut-out switch remains closed.

1,008,482. CONSTANT POTENTIAL ELECTRICAL SYSTEM; D. R. Lovejoy, Freneau, N. J. App. filed May 7, 1910. Resistance for adapting a high-voltage current to operating telephones, bells, etc.

1,008,495. CONTROL SYSTEM FOR ELECTRIC MOTORS; J. F. Schnable, Cleveland, Ohio. App. filed March 18, 1910. Safety device; permits the load to be lowered without a mechanical brake.

1,008,496. PROTECTIVE DEVICE; E. O. Schweitzer and N. J. Conrad, Chicago, Ill. App. filed April 12, 1910. A fuse under tension of a spring in a solution of carbon tetrachloride.

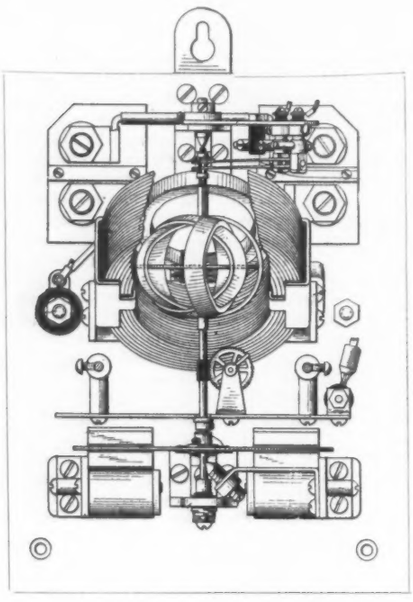
1,008,506. TROLLEY-WHEEL SUPPORT; C. A. Welsbacher and J. Staab, Pittsburgh, Pa. App. filed March 6, 1911. A rotatable head with a latch.

1,008,514. ELECTRIC SWITCH MECHANISM; R. W. Armstrong, New York, N. Y. App. filed Oct. 26, 1907. Pivoted key switches for switchboard.

1,008,521. ELECTRIC BLOCK-SIGNAL SYSTEM; W. J. Bell, Los Angeles, Cal. App. filed Dec. 2, 1908. Double-track trolley railway system.

1,008,522. MOUTHPIECE FOR TELEPHONES; F. O. Beuermann, New York, N. Y. App. filed Nov. 11, 1910. Porcelain bell with metallic attaching ring.

1,008,525. SECONDARY BATTERY; C. J. Coleman, Rockaway, N. J. App. filed Oct. 7, 1903. Has a marginal insulating packing frame between the plates.



1,008,617.—Electric Meter.

1,008,535. MOLDED CONDUCTOR; E. G. Gilson, Schenectady, N. Y. App. filed March 7, 1910. Iron and graphite for a dynamo-electric machine brush.

1,008,543. TROLLEY; F. H. Howard, Reading, Pa. App. filed April 8, 1911. Removable ball-bearing wheel.

1,008,549. ELECTRICAL MEASURING INSTRUMENT; W. Klinckert, Berlin, Germany. App. filed April 8, 1908. D'Arsonval type, the magnetic element being readily dismounted.

1,008,560. SUPPORT FOR THIRD RAILS; W. B. Potter, Schenectady, N. Y. App. filed Oct. 21, 1905. A laterally extending bracket carries a yoke which supports the rail.

1,008,561. DYNAMO-ELECTRIC MACHINE; H. G. Reist, Schenectady, N. Y. App. filed May 19, 1909. Field-magnet structure with distributed winding.

1,008,562. ELECTRIC-MOTOR DRIVE; R. H. Rogers, Schenectady, N. Y. App. filed June 23, 1909. Motors for driving the different sets of rolls of a paper-making machine.

1,008,571. HOLDING AND RELEASING DEVICE FOR ELECTRICAL INSTRUMENTS; H. B. Taylor, Albany, N. Y. App. filed Aug. 16, 1910. For protecting the parts of an incased instrument during shipment.

1,008,572. PROCESS AND APPARATUS FOR INSULATING ELECTRIC CONDUITS; C. Thibodeau, Cambridge, Mass. App. filed March 26, 1910. A tank with bath compound and a heated stripping die.

1,008,577. HIGH-FREQUENCY ALTERNATOR; E. F. W. Alexanderson, Schenectady, N. Y. App. filed April 26, 1909. A solid magnetic inductor is driven at high speed between the faces of the laminated stator rings.

1,008,580. ELECTRIC LOCOMOTIVE; A. F. Batchelder, Schenectady, N. Y. App. filed April 30, 1909. Two-truck type with separate motors, the wheels of each truck being connected.

1,008,581. ELECTRIC LOCOMOTIVE TRUCK; A. F. Batchelder, Schenectady, N. Y. App. filed Nov. 13, 1909. Two-truck type with universal hinge between the trucks.

1,008,582. ELECTRIC LOCOMOTIVE; A. F. Batchelder, Schenectady, N. Y. App. filed April 30, 1909. Yielding connection between the motor armature and the shaft.

1,008,588. FILAMENT; W. D. Coolidge, Schenectady, N. Y. App. filed Aug. 1, 1906. A tubular slitted filament of tungsten.

1,008,617. ELECTRIC METER; G. A. Scheeffer, Indianapolis, Ind. App. filed Jan. 14, 1910. Compensating mechanism.

1,008,622. ELECTRIC HEATER; E. Thomson, Swampscott, Mass. App. filed March 18, 1909. A high-speed motor operating at its greatest inefficiency and with a circulating system for absorbing and distributing the heat.

1,008,623. TRANSFORMER; M. O. Troy, Schenectady, N. Y. App. filed Feb. 2, 1911. Submerged terminal board.

1,008,625. MOTOR-CONTROL SYSTEM; H. E. White, Schenectady, N. Y. App. filed June 19, 1909. Power and dynamic brake control.

1,008,628. BOILER CONSTRUCTION AND MEANS FOR MAKING THE SAME; C. A. Brown, Hinsdale, Ill. App. filed Aug. 1, 1910. The flues are welded to the heads.

1,008,629. FUSE ATTACHMENT FOR ELECTRIC LIGHTS; J. M. Cummings, Evansville, Ind. App. filed Jan. 31, 1911. In the handle of a portable lamp.

1,008,701. RHEOSTAT; L. Crump, Centralia, Mo. App. filed Nov. 23, 1910. A fluid of high resistance with immersed terminals.

1,008,728. VACUUM-TUBE ELECTRIC APPARATUS; D. McF. Moore, Newark, N. J. App. filed Feb. 7, 1906. Gas fed into the tube at a number of points for uniformity.

1,008,729. TENSION ADJUSTMENT FOR PULL SWITCHES; C. D. Platt, Bridgeport, Conn. App. filed Dec. 21, 1910. Frictional adjusting device for lamp sockets.

1,008,756. SELF-SWITCHING ALARM; B. Uhlmann, Garfield, N. J. App. filed July 26, 1910. Spring pressed push-button for doors.

1,008,806. METALLIC FILAMENTS FOR INCANDESCENT ELECTRIC LAMPS; K. Farkas, New York, N. Y. App. filed Aug. 9, 1909. Tungsten power with a glutinous organic binder is heated in aluminum oxide and cerium oxide.

1,008,807. METALLIC FILAMENTS FOR INCANDESCENT ELECTRIC LAMPS; K. Farkas, New York, N. Y. App. filed Aug. 9, 1909. Treatment as in Patent No. 1,008,806, but first in vacuo and then in oxygen.

1,008,811. STARTER AND REGULATOR FOR COMPOUND MOTORS; W. H. Caulke, Milwaukee, Wis. App. filed Feb. 6, 1911. Combined armature and field-current regulator.

1,008,852. STORAGE-BATTERY ELECTRODE AND PROCESS OF MAKING IT; W. Morrison, Des Moines, Ia. App. filed Sept. 29, 1911. Lead-peroxide plate bonded by celluloid.

1,008,853. STORAGE-BATTERY ELECTRODE AND PROCESS OF MAKING IT; W. Morrison, Des Moines, Ia. App. filed Sept. 29, 1911. The active material is bonded by rubber.

1,008,854. STORAGE-BATTERY ELECTRODE AND PROCESS OF MAKING IT; W. Morrison, Des Moines, Ia. App. filed Sept. 29, 1911. The active material is bonded by the solid reaction products of lead oxide, a chromium salt and gylcerine.

1,008,860. ELECTROLYTE FOR ALUMINUM CELLS; F. W. Peck, Jr., Schenectady, N. Y. App. filed Feb. 5, 1909. Contains a borate and a tartrate of ammonium and glycerine.

1,008,870. THERMOSTATIC SWITCH; B. J. Smith, Modesto, Cal. App. filed April 5, 1911. For adjusting incubators, etc.

1,008,879. ELECTRIC CONNECTION PLUG; R. B. Wolcott, East Cleveland, Ohio. App. filed Feb. 19, 1910. Two-piece socket plug.

1,008,800. TELEPHONE REPEATING CIRCUITS; C. Adams-Randal, New York, N. Y. App. filed Dec. 20, 1910. Independent main-line circuits inductively related through local relay circuits.

1,008,881. TELEPHONE REPEATING SYSTEM; C. Adams-Randal, New York, N. Y. App. filed Dec. 20, 1910. A plurality of independent sending and receiving main-line circuits related inductively by a single relay.

1,008,882. CIRCUITS FOR TELEPHONE REPEATING SYSTEMS; C. Adams-Randal, New York, N. Y. App. filed Jan. 3, 1911. Involves a relay connected from one side of one of the main lines to the ground.

1,008,913. COLLECTOR FOR TRAVELING CRANES AND THE LIKE; E. L. Hoofring, Vandergrift, Pa. App. filed April 5, 1909. The grooved collector bar is readily detachable from its support.

1,008,922. SOLDERING TOOL; H. P. MacLagan, Park Ridge, Ill. App. filed June 20, 1910. The heating coil is in a shell which carries the soldering tip.

1,008,933. INCANDESCENT LAMP; S. D. Washburn, Boston, Mass. App. filed Jan. 11, 1908. Two connected conical spirals.

1,008,937. ELECTRIC LOCOMOTIVE; A. F. Batchelder, Schenectady, N. Y. App. filed April 30, 1909. Spring suspension system for the truck frames.

1,008,938. RAILWAY SWITCH SIGNAL; W. J. Bell, Los Angeles, Cal. App. filed Dec. 2, 1908. Electric block system for trolley roads.

1,008,955. FIRE-ALARM BOX; F. W. Cole, Newton, Mass. App. filed April 25, 1908. Visual signal when the box needs rewinding.

1,008,959. BOND-WIRE-RETAINING NUT LOCK; W. E. Davin, McKee's Rocks, Pa. App. filed March 7, 1911. Spring washer plate with a retaining finger.

1,008,960. FIRE-ALARM SYSTEM; W. L. Denio, Rochester, N. Y. App. filed April 5, 1909. Thermostatic system with means for testing.

1,008,968. TROLLEY; H. Jolly, Pittsburgh, Pa. App. filed Jan. 10, 1911. Three rollers in the harp which can rock on the pole.

1,008,977. WAVE DETECTOR; T. H. Lyon, Renfrew, Pa. App. filed Oct. 12, 1911. Cerusite.

1,009,008. ELECTRIC DENTAL HEATER; W. & D. Asch, Berlin, Germany. App. filed Dec. 22, 1910. Hollow tongs for hardening cement fillings in teeth.

1,009,013. ELECTRIC APPARATUS FOR TRANSMITTING AND RECEIVING SIGNALS; A. Barr and W. Stroud, Leeds, England. App. filed Jan. 28, 1907. Step-by-step system for sending and indicating gun ranges in artillery fire control.

1,009,015. ELECTRIC-SIGNAL-ACTUATING MECHANISM; W. J. Bell, Los Angeles, Cal. App. filed Feb. 13, 1911. Pivoted trolley actuated device.

13,312 (Reissue). CARTRIDGE FUSE; A. F. Daum, Pittsburgh, Pa. App. filed June 14, 1910. Detachable end caps. Original Patent No. 961,716.